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(12) **United States Patent**
Yajima et al.

(10) **Patent No.: US 7,753,351 B2**
(45) **Date of Patent: *Jul. 13, 2010**

(54) **CLAMP DEVICE**

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(73) Assignee: **Nissan Motor Co., Ltd.**, Yokohama-shi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 77 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/127,079**

(22) Filed: **May 27, 2008**

(65) **Prior Publication Data**

US 2008/0224376 A1 Sep. 18, 2008

Related U.S. Application Data

(63) Continuation of application No. 11/085,050, filed on Mar. 22, 2005, now Pat. No. 7,377,503.

(30) **Foreign Application Priority Data**

Mar. 31, 2004 (JP) 2004-106783

(51) **Int. Cl.**
B25B 5/02 (2006.01)

(52) **U.S. Cl.** **269/152**; 269/164; 269/32

(58) **Field of Classification Search** 269/164, 269/32, 285, 238, 20, 27, 152, 64, 271
See application file for complete search history.

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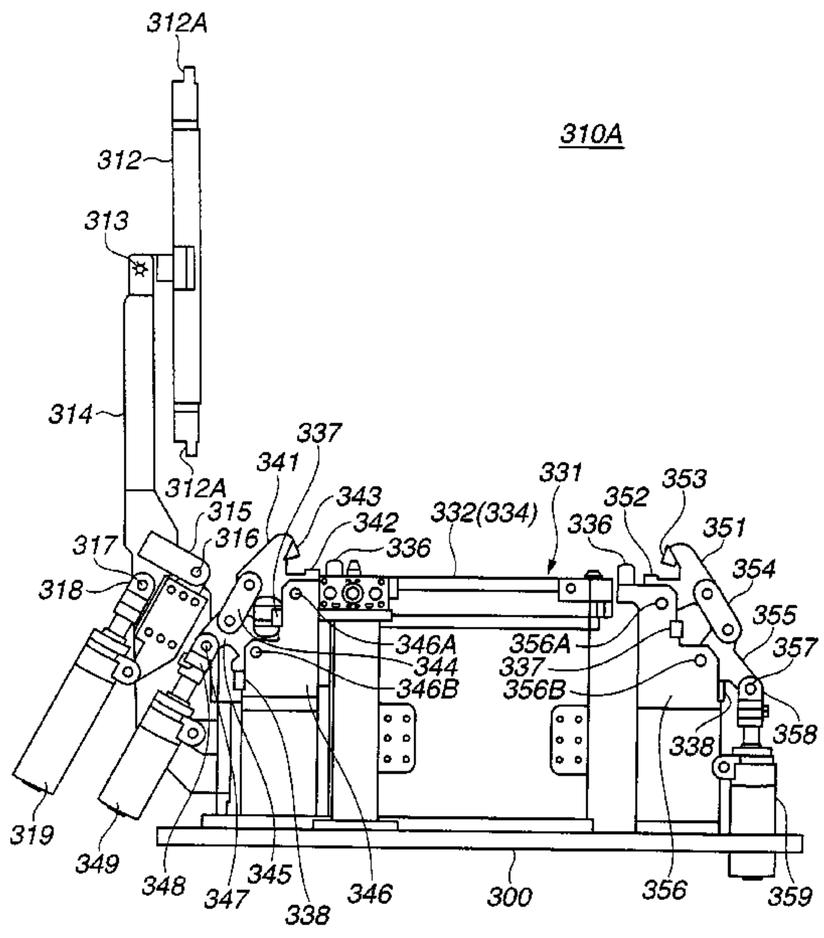
Primary Examiner—Lee D Wilson
(74) *Attorney, Agent, or Firm*—Foley & Lardner LLP

(57) **ABSTRACT**

The disclosed clamp device for clamping blank pieces may comprise a mounting table, first and second clamping units, positioning units, and lock units. The mounting table is for placing thereon first and second blank pieces. The first and second clamping units have respective clamp plates that are able to be put on the first and second blank pieces while permitting a guided movement of the first and second blank pieces on the mounting table. The positioning units move the first and second blank pieces to establish a positioning of the first and second blank pieces on the mounting table. The lock units apply a given force to the first and second clamp plates to lock the first and second blank pieces.

15 Claims, 25 Drawing Sheets

CLD



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JP	11-320168	A	11/1999
JP	11-320168 (A)		11/1999
JP	2001-287090	A	10/2001
JP	2001-287090 (A)		10/2001
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KR	1998-033386	A	7/1998

* cited by examiner

FIG.1

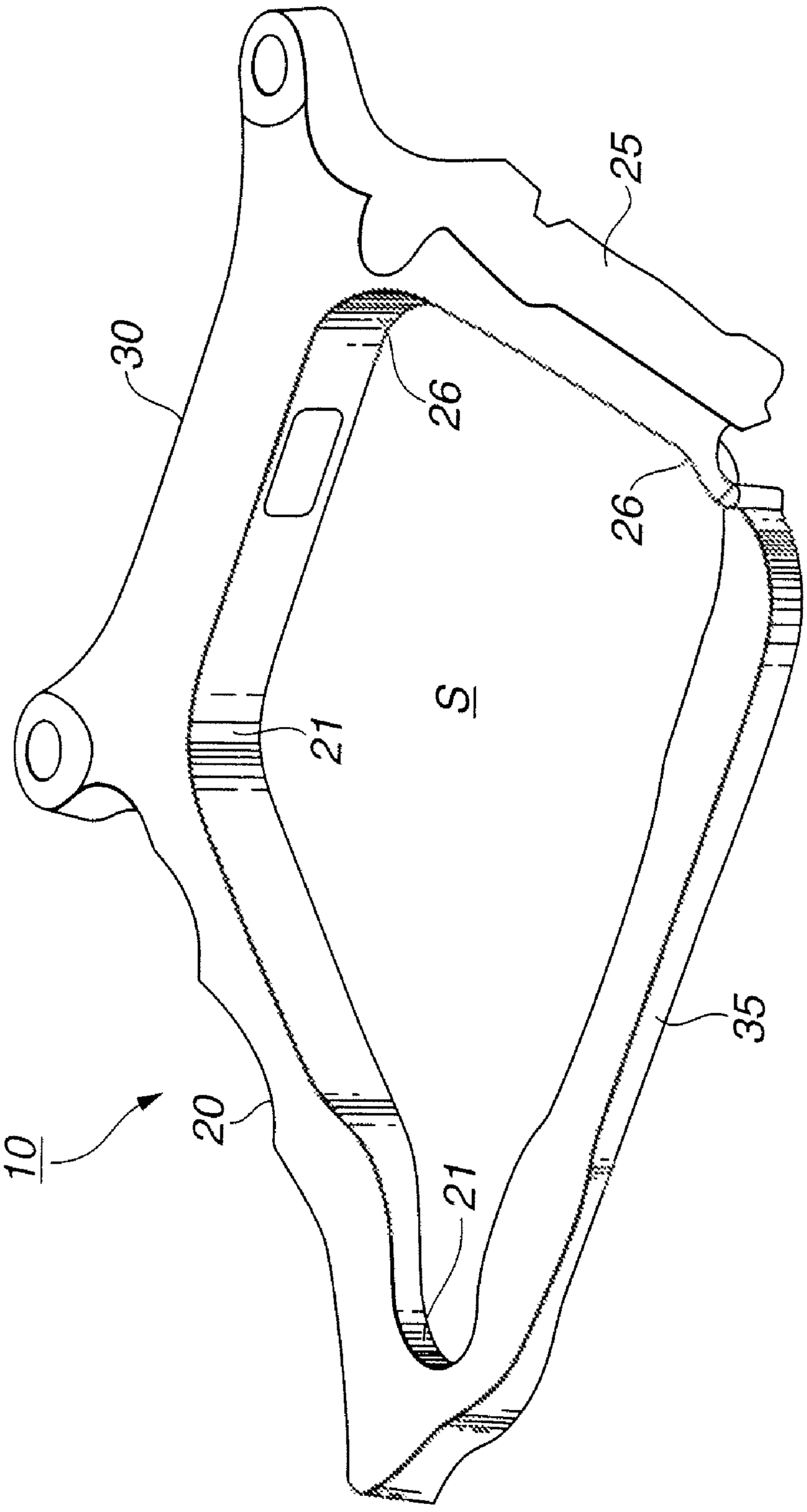
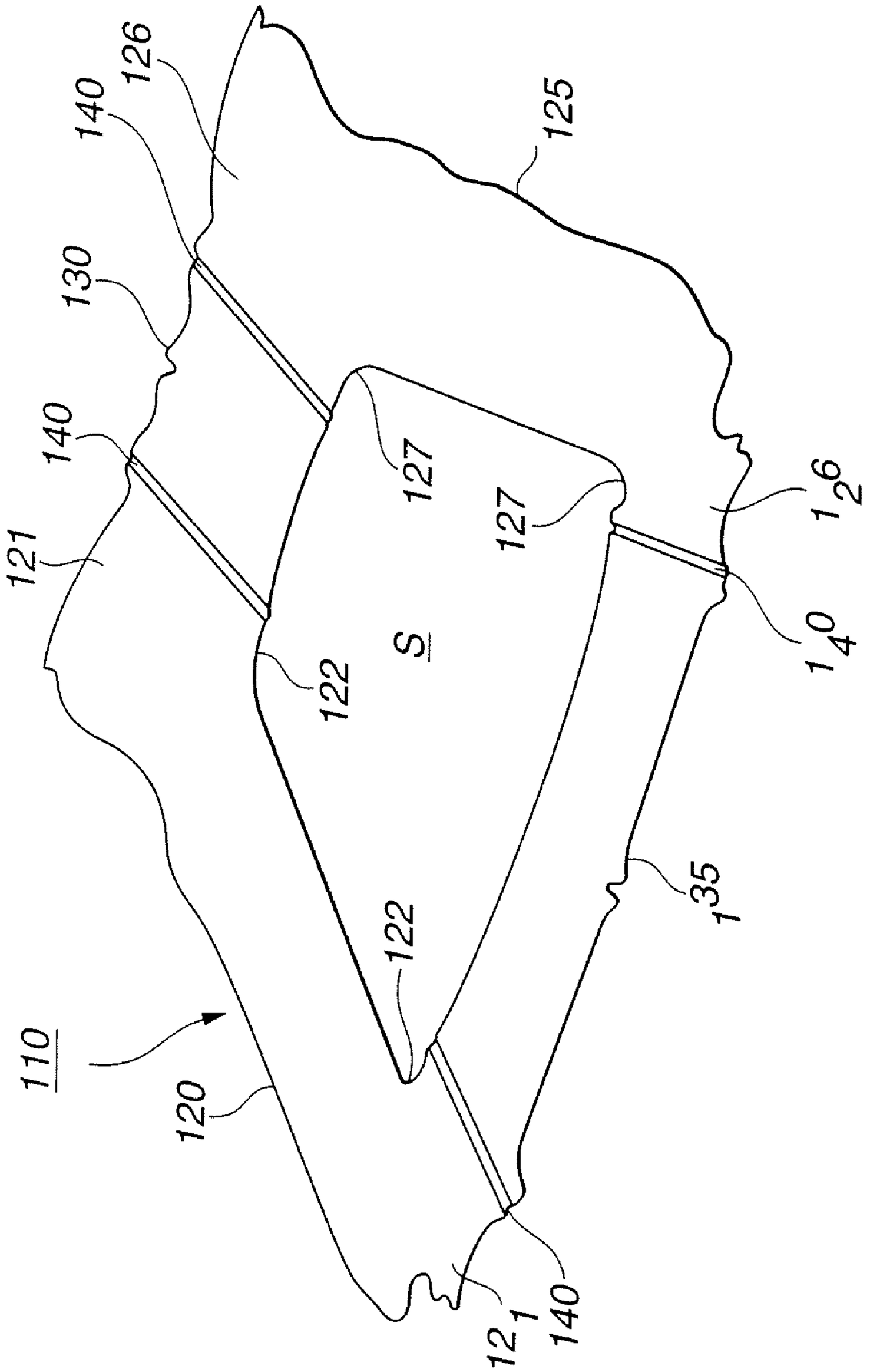


FIG.2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122
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121
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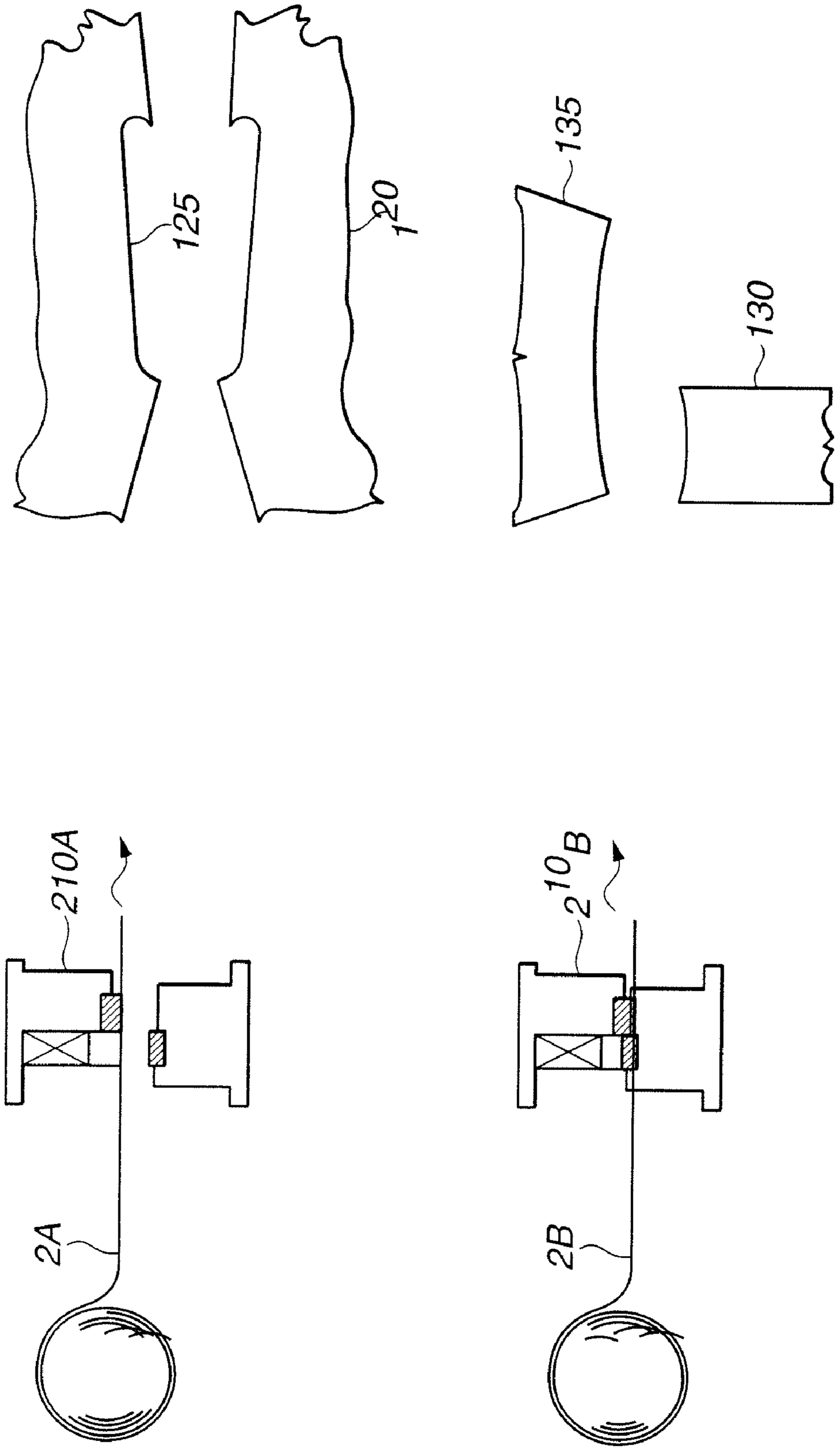
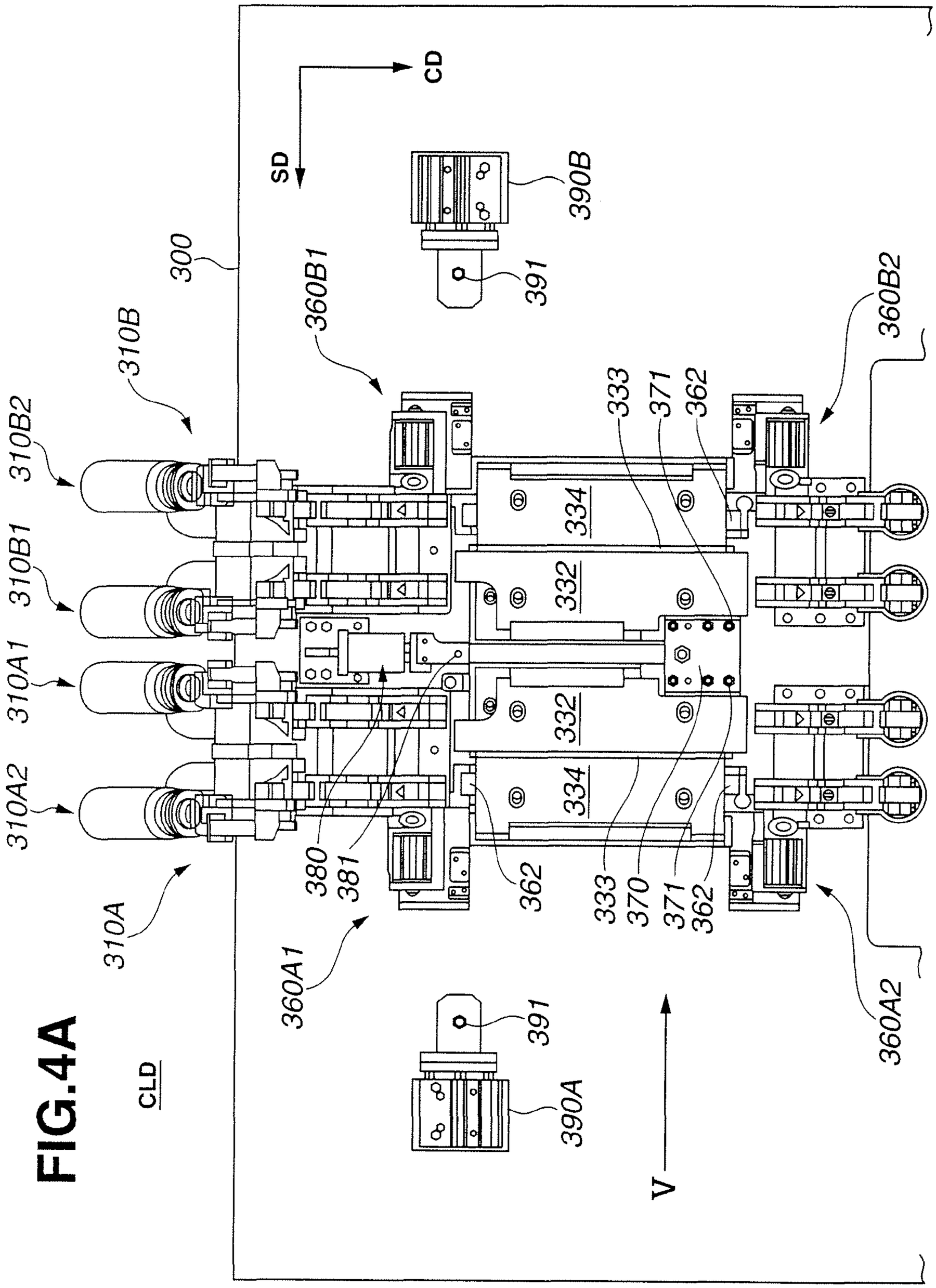
FIG.3

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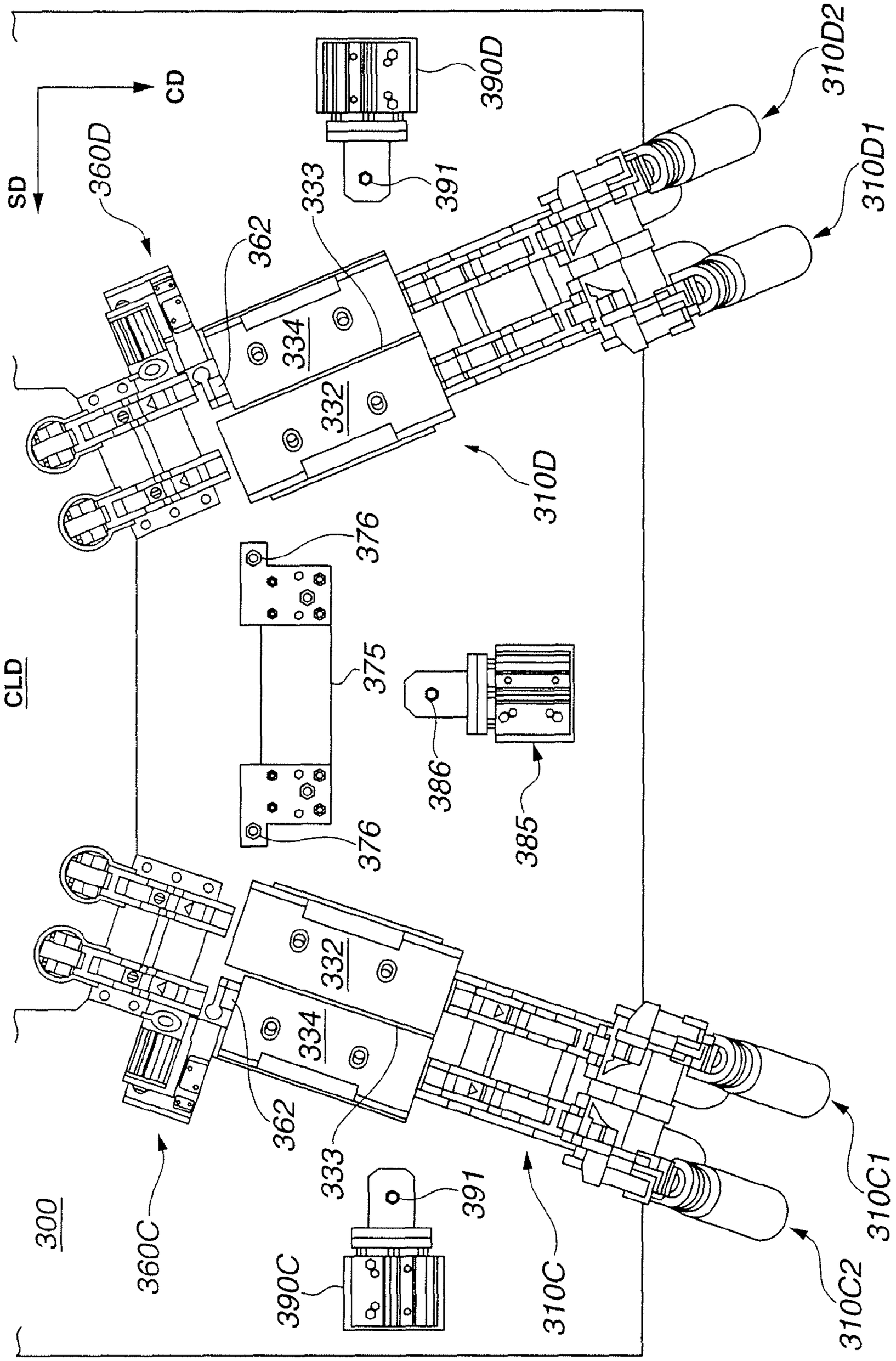
310B
360B1
390B
391
360B2
310B2
310B1
310A1
310A2
333
371
362
334
332
380
381
362
333
370
371
362
310A
360A1
391
390A
360A2
CLD
V

FIG.4A

FIG.4B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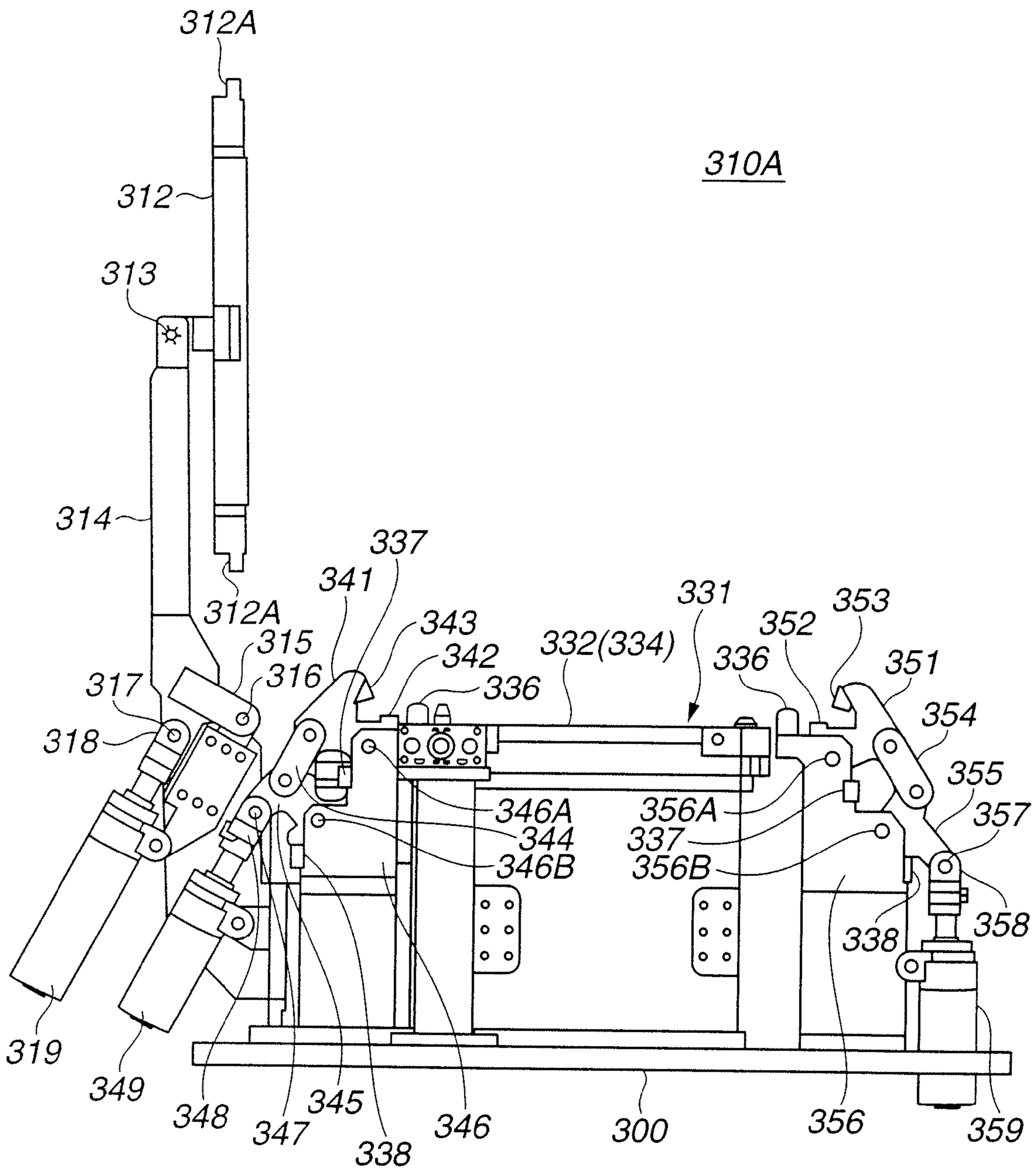
CLD
300
360C
390C
391
333
362
334
332
310C
310C2
310C1

FIG.5


CLD
310A
312A
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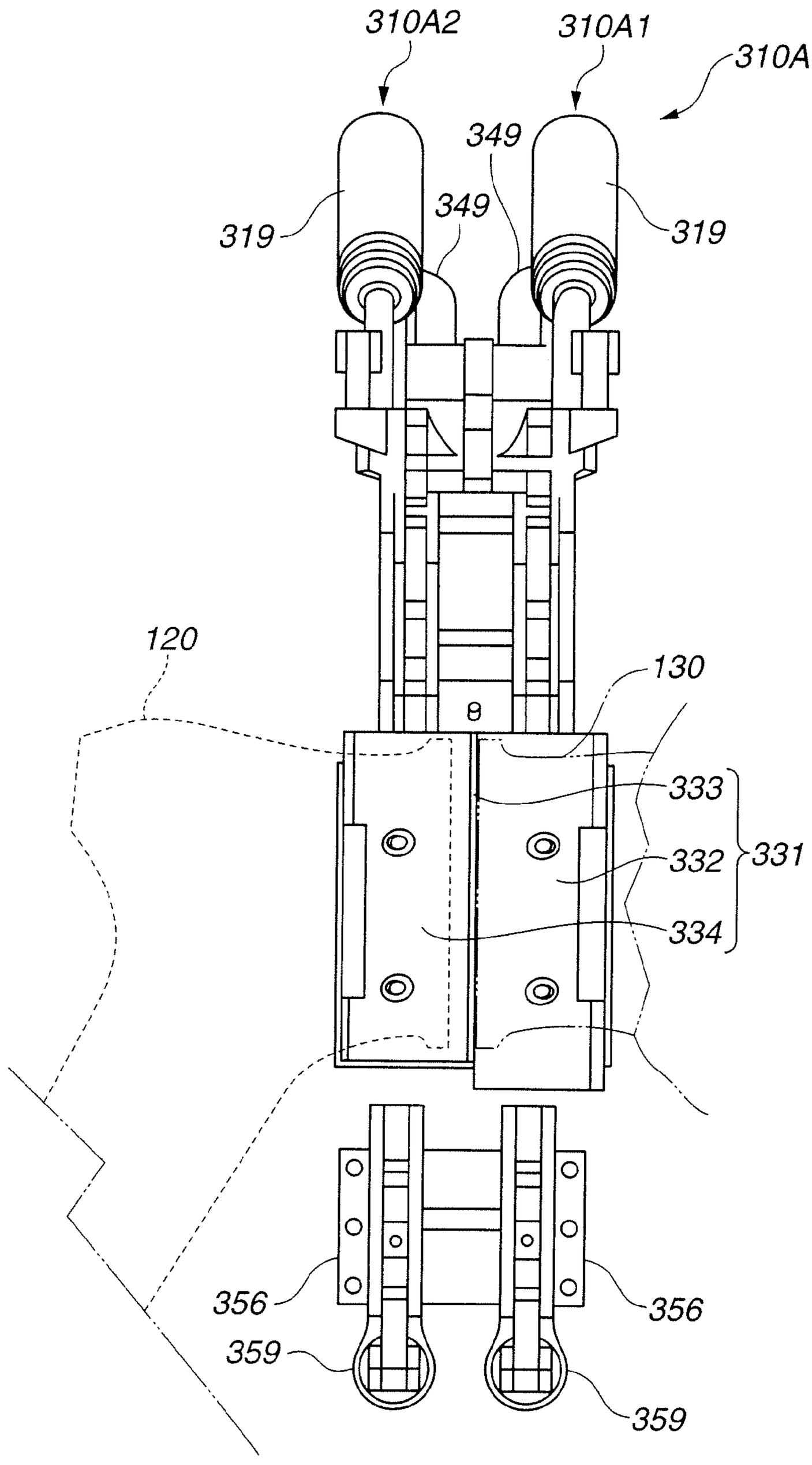
313
314
315
316
317
318
319
349
348
347
345
338
346
300
356
359
337
341
343
342
336
332(334)
331
353
352
336
351
354
355
357
358
338
346A
344
346B
356A
337
356B

FIG.6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319
120
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333
332
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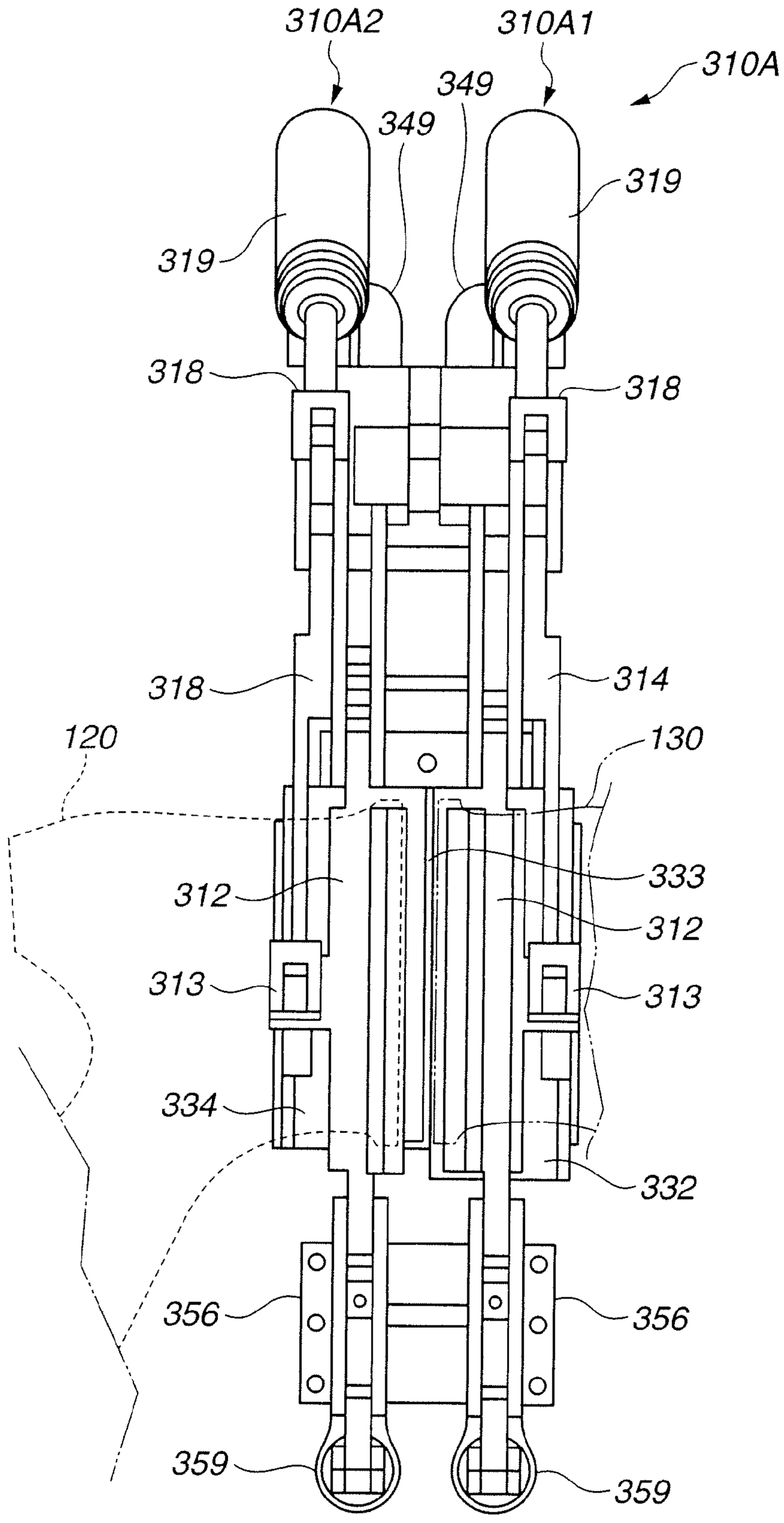
356
359
359

FIG.7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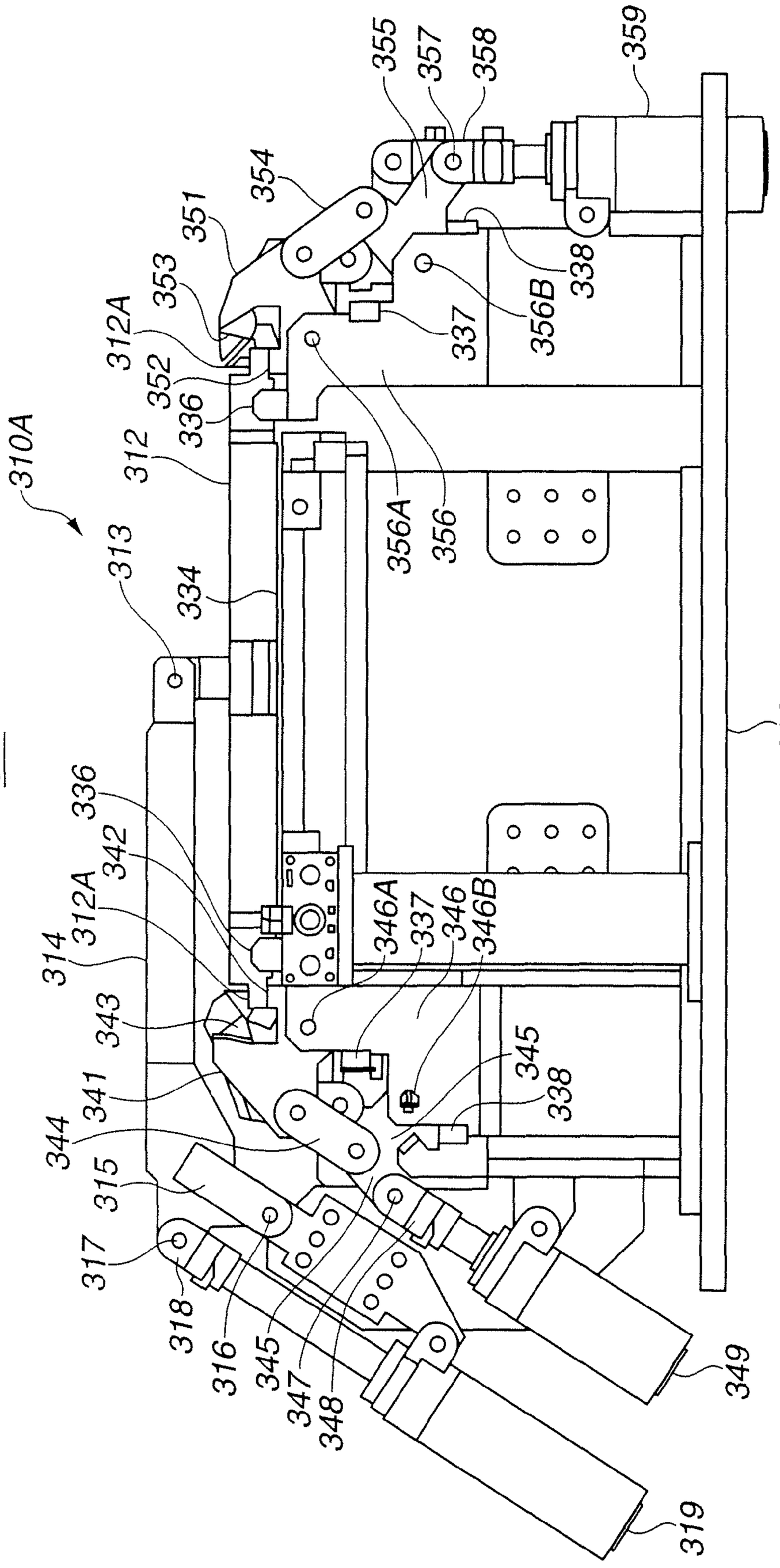
356
359
359

FIG.8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351
354
355
357
358
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356A
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356B
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346B
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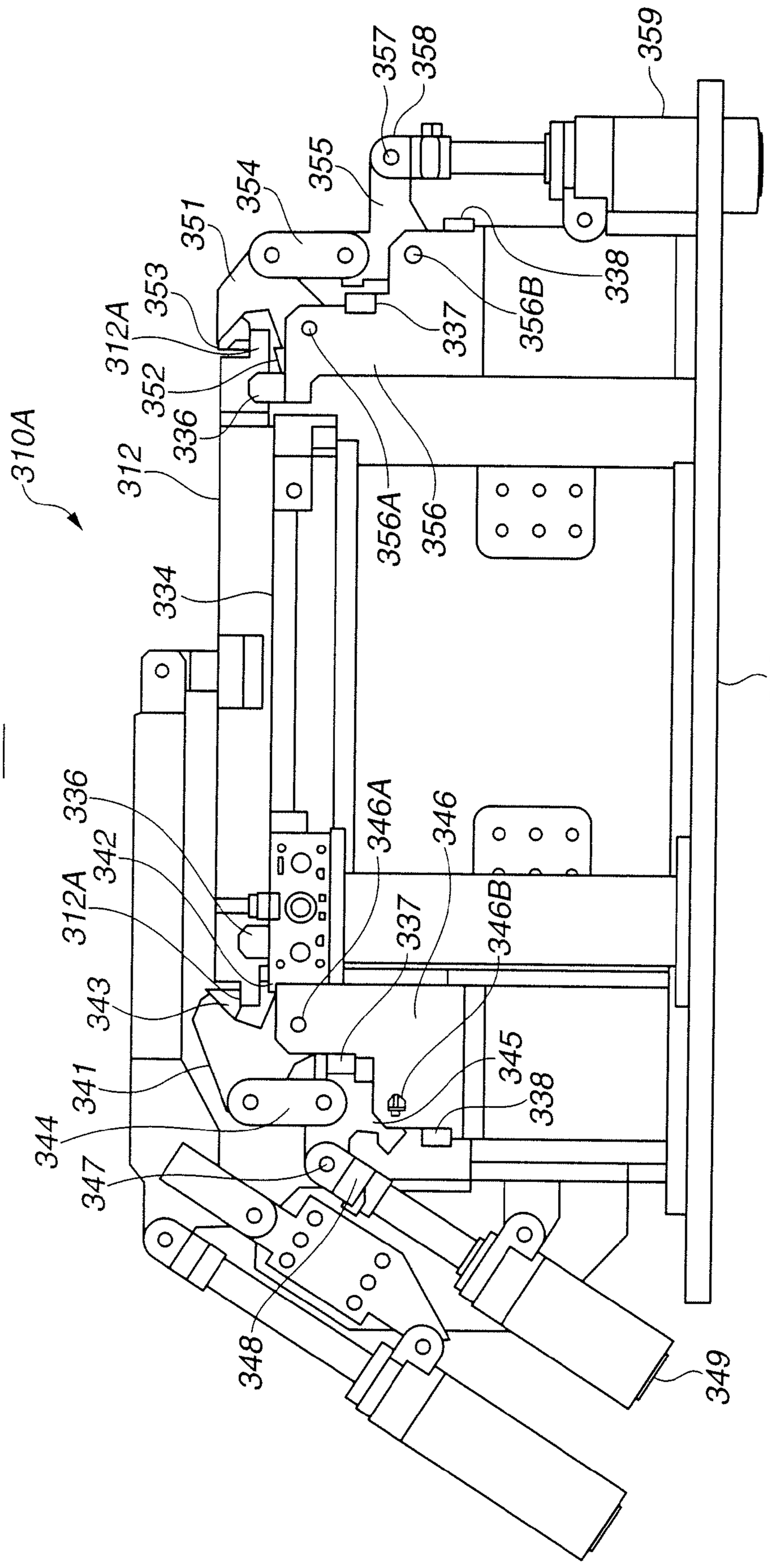
349
319
300

FIG.9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346A
346B
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352
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354
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356A
356B
357
358
359
300

FIG.10

CLD

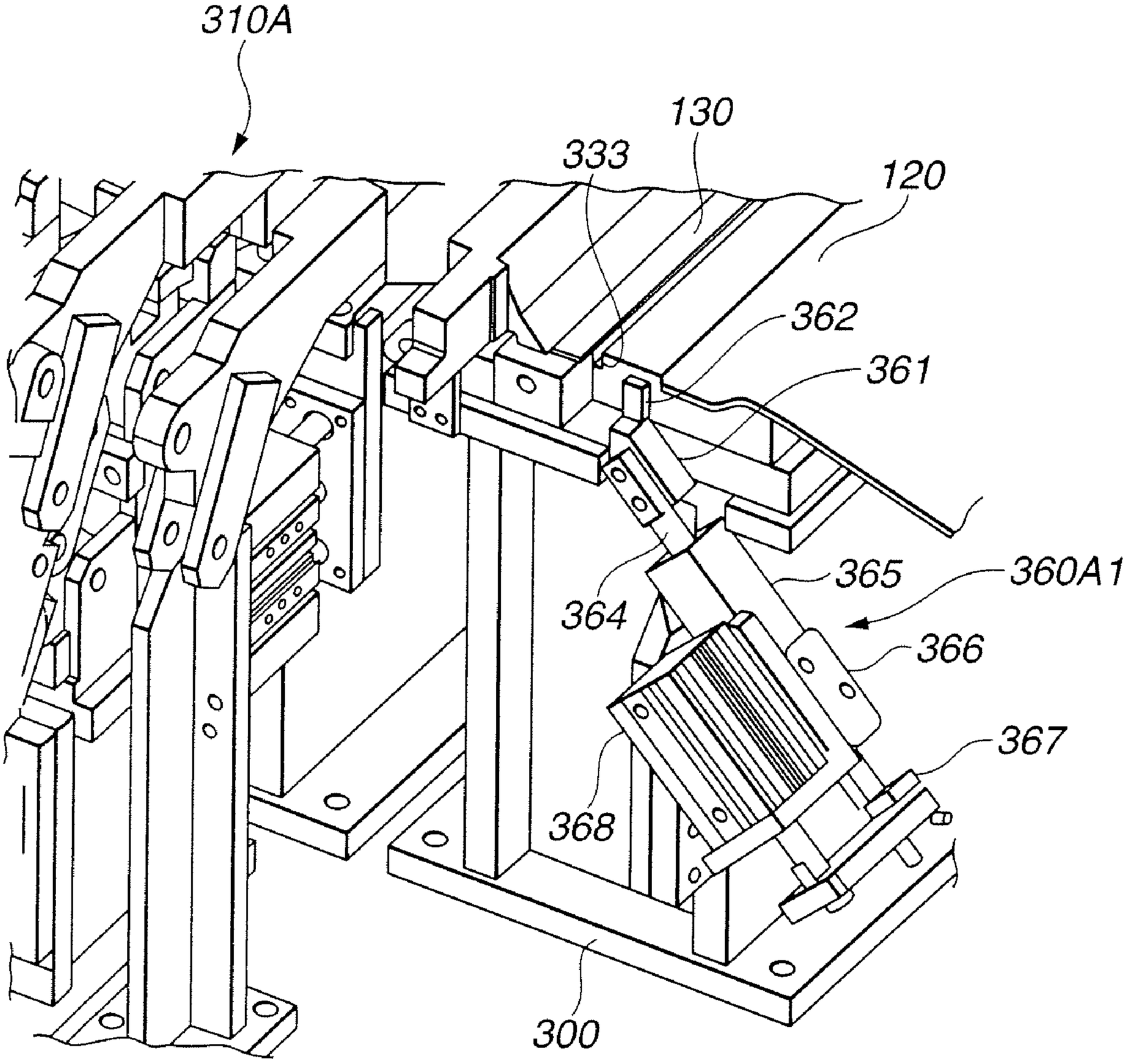


FIG.11

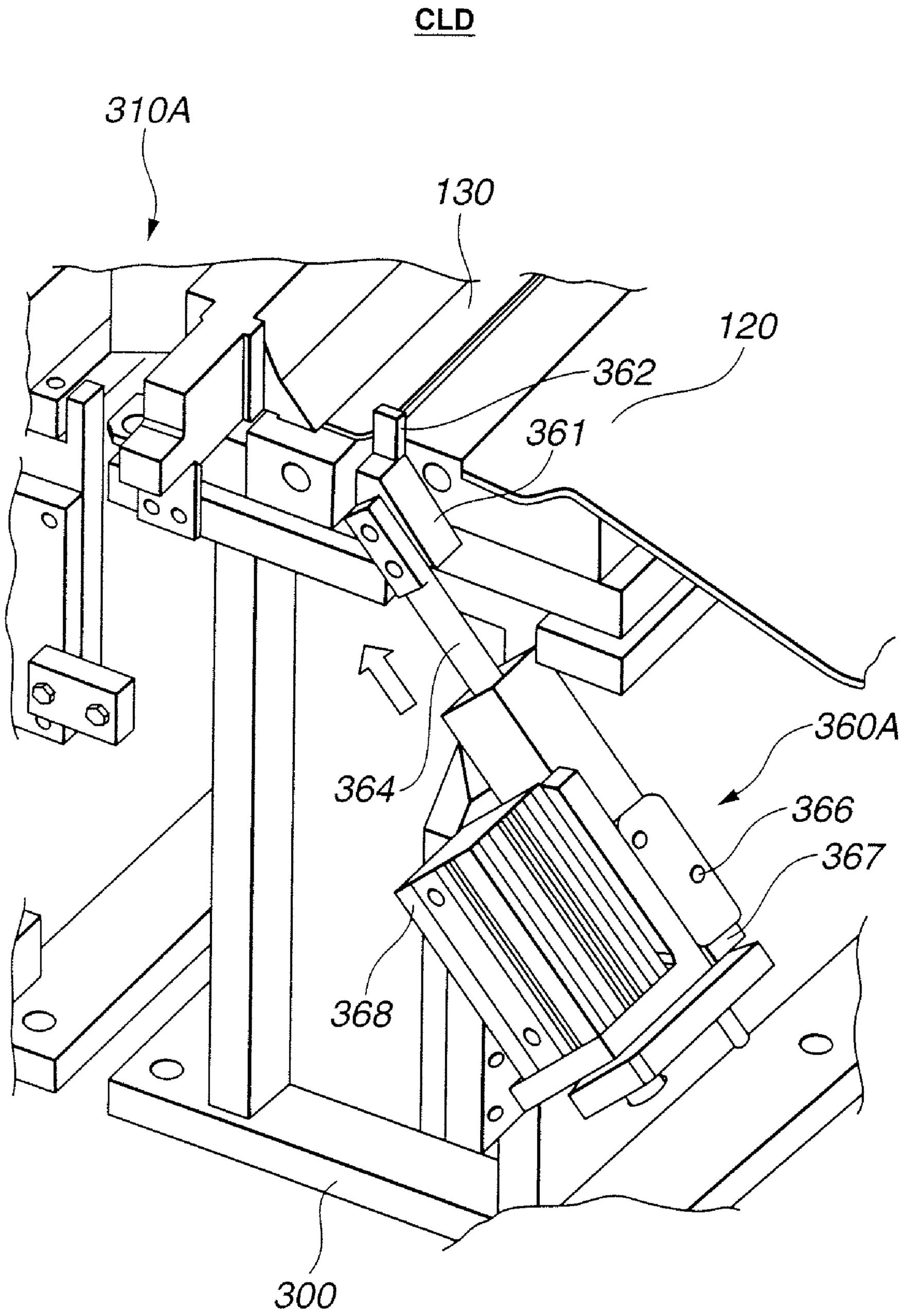
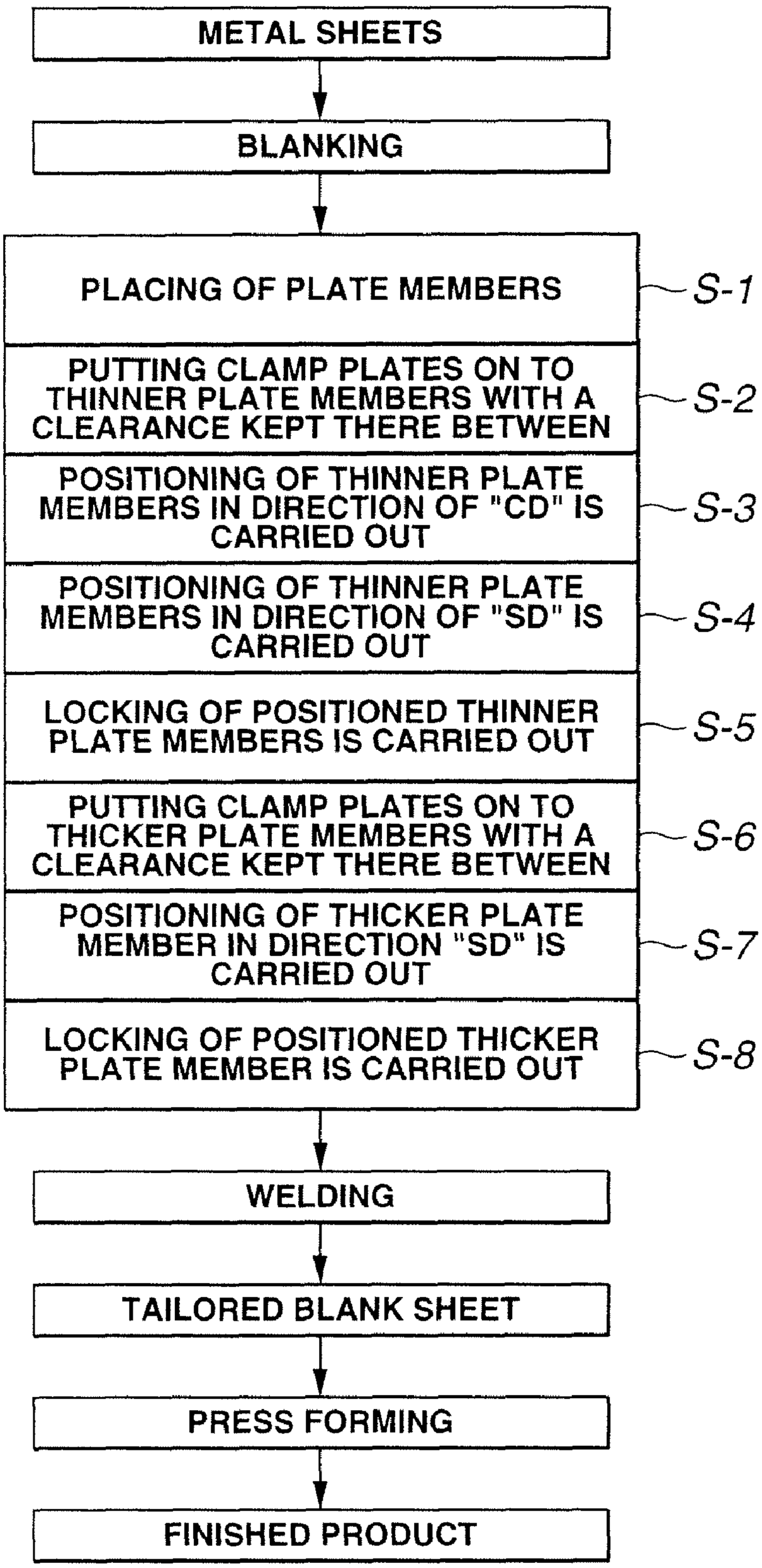
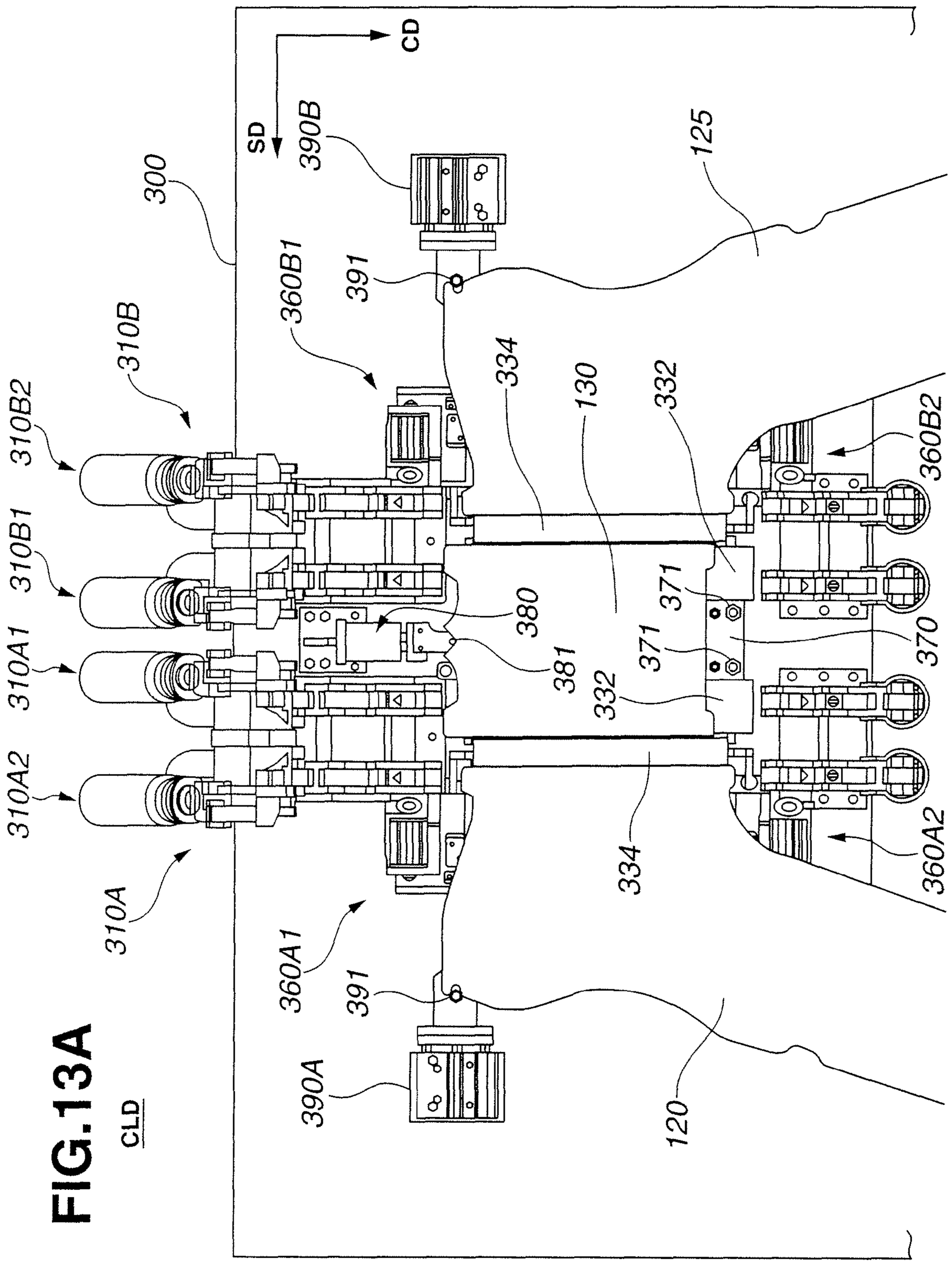


FIG.12


METAL SHEETS
BLANKING
PLACING OF PLATE MEMBERS
S-1
PUTTING CLAMP PLATES ON TO THINNER PLATE MEMBERS WITH A CLEARANCE KEPT THERE BETWEEN
S-2
POSITIONING OF THINNER PLATE MEMBERS IN DIRECTION OF "CD" IS CARRIED OUT
S-3
POSITIONING OF THINNER PLATE MEMBERS IN DIRECTION OF "SD" IS CARRIED OUT
S-4
LOCKING OF POSITIONED THINNER PLATE MEMBERS IS CARRIED OUT
S-5
PUTTING CLAMP PLATES ON TO THICKER PLATE MEMBERS WITH A CLEARANCE KEPT THERE BETWEEN
S-6
POSITIONING OF THICKER PLATE MEMBER IN DIRECTION "SD" IS CARRIED OUT
S-7
LOCKING OF POSITIONED THICKER PLATE MEMBER IS CARRIED OUT
S-8
WELDING
TAILORED BLANK SHEET
PRESS FORMING
FINISHED PRODUCT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310B2
360B2
310B1
380
371
310A1
381
371
370
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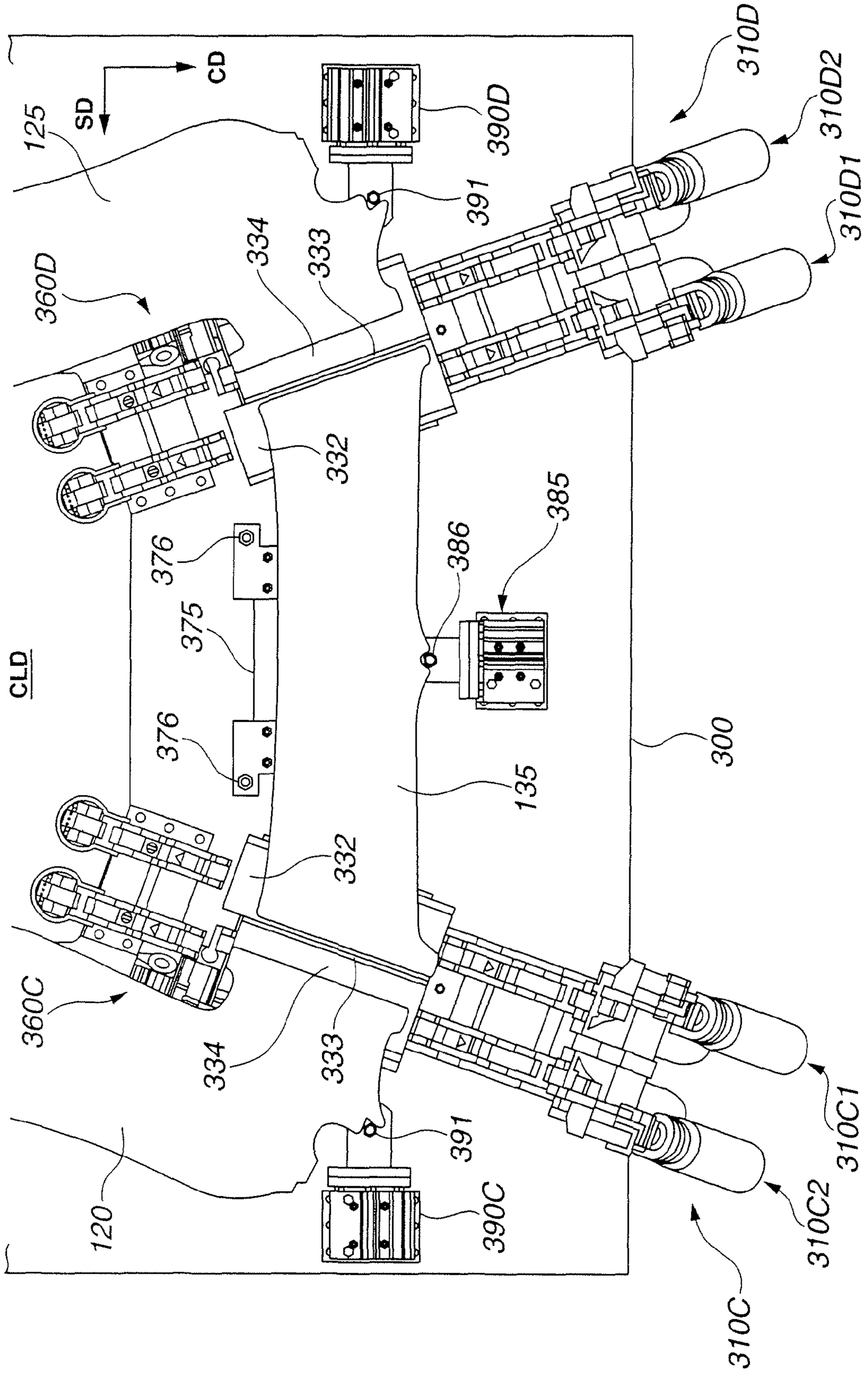
310A2
334
360A2
310A
360A1
391
390A
120

FIG.13A

CLD

FIG.13B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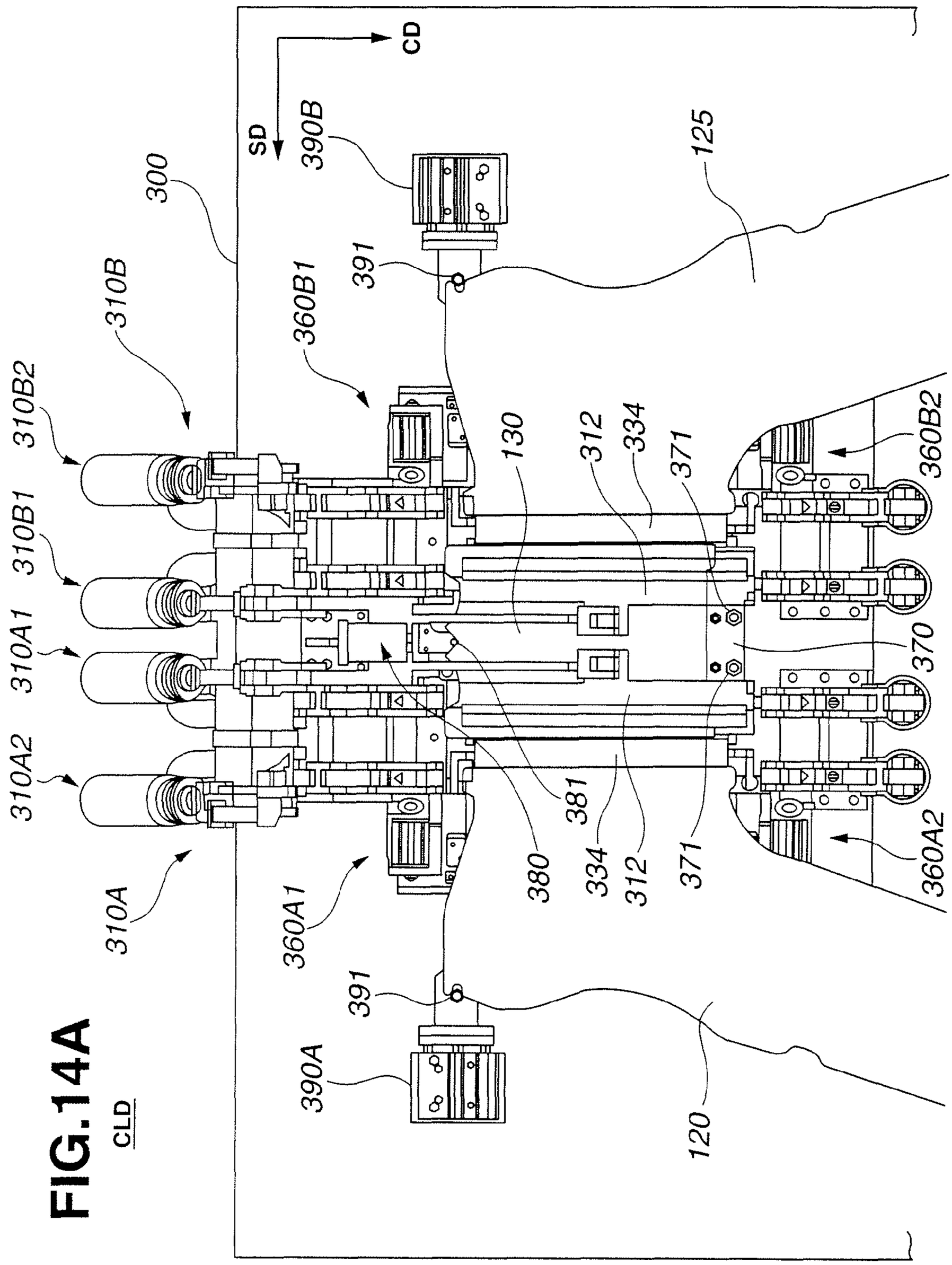
310C2
310C1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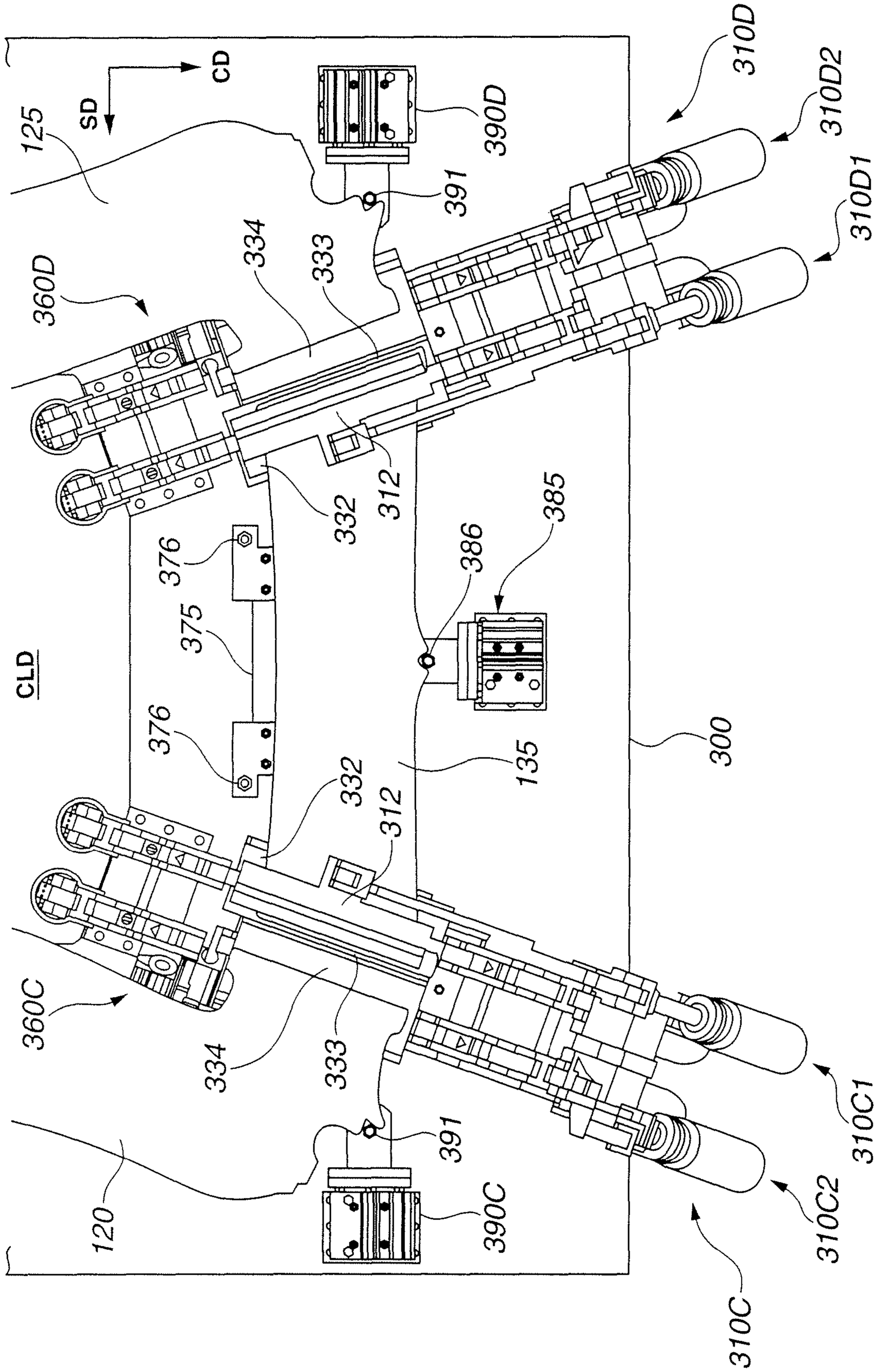
120
CLD

FIG.14A

FIG.14B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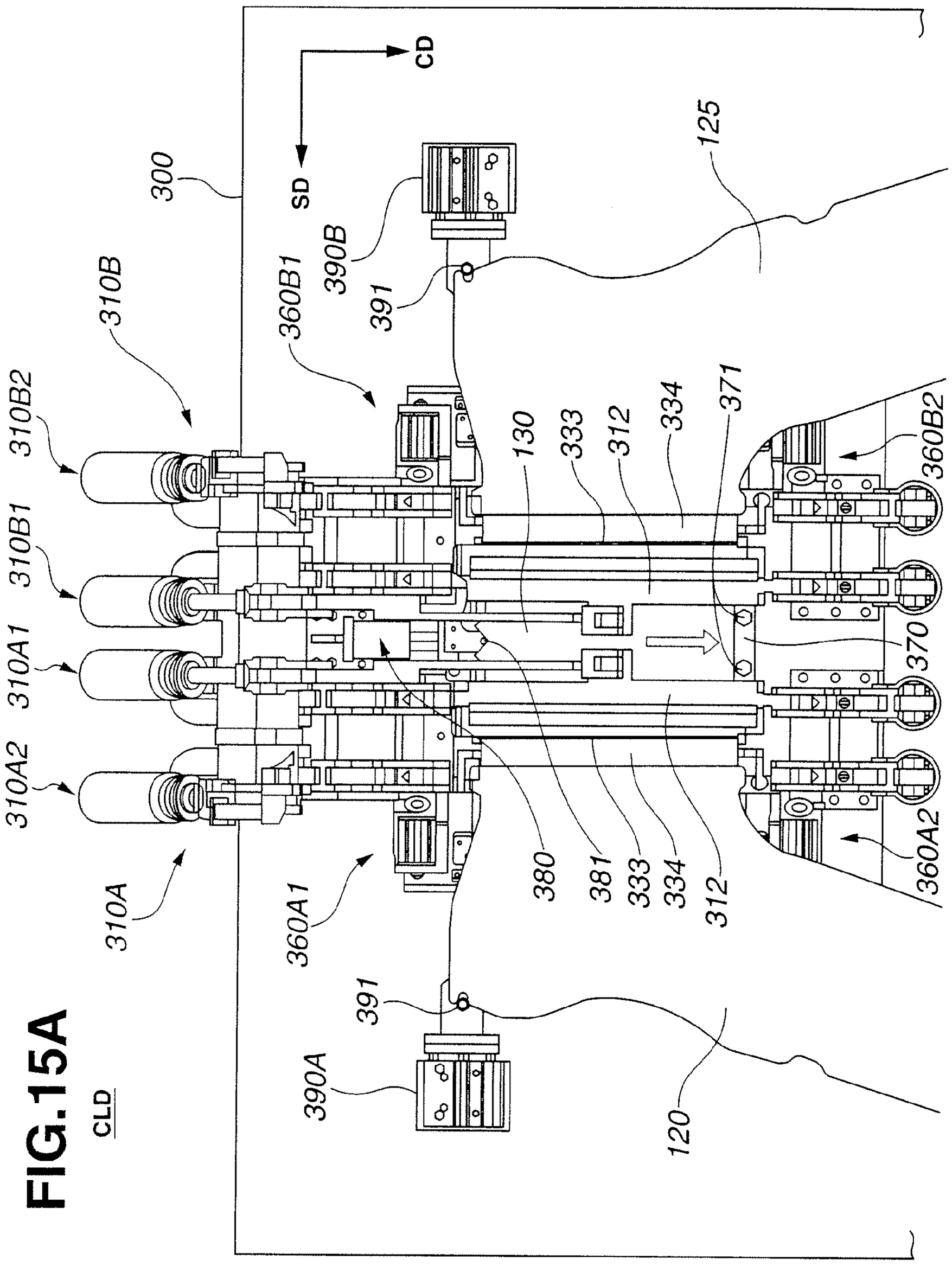
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360B2
360A2
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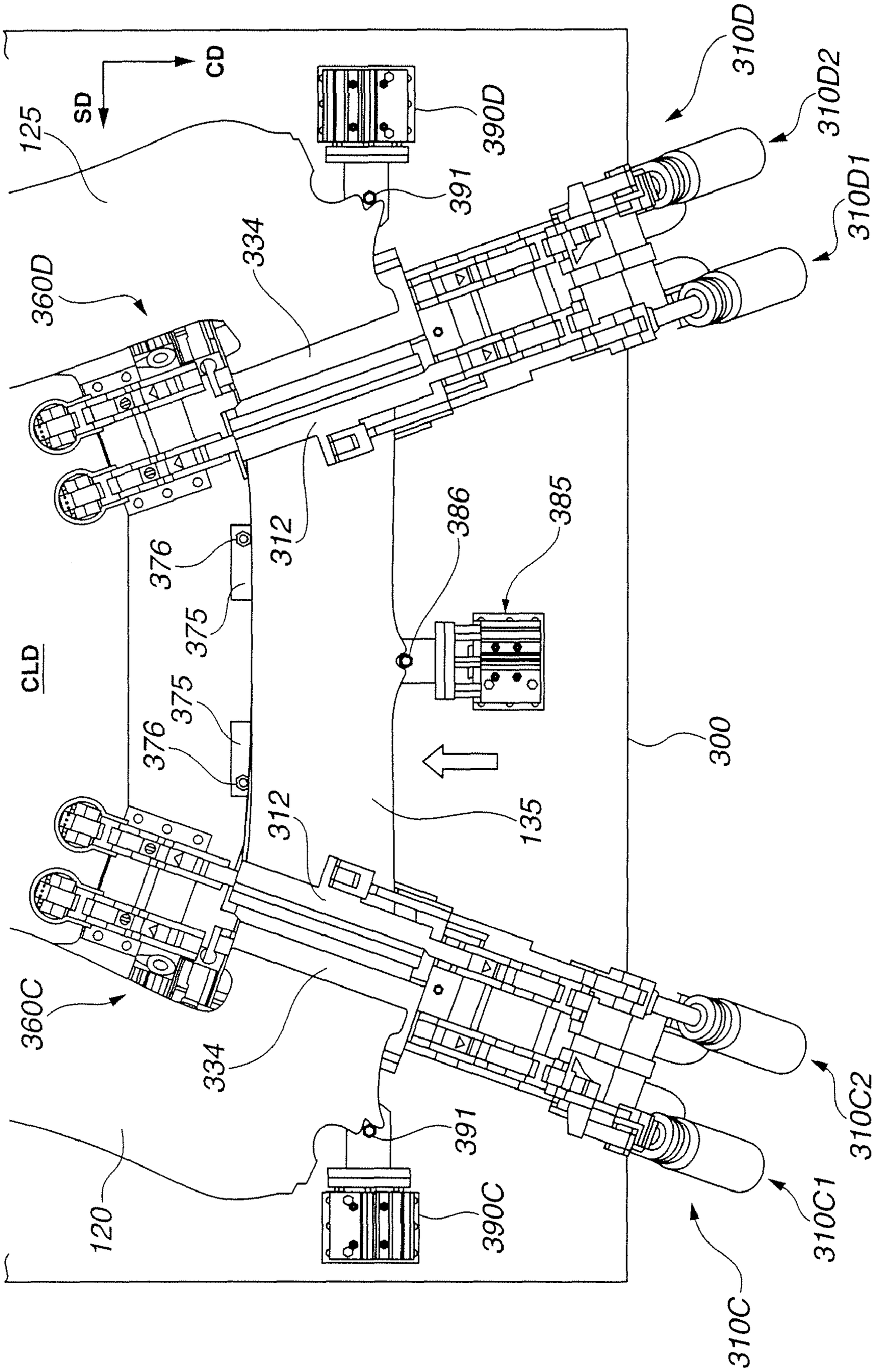
CLD

FIG.15A

FIG.15B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310C
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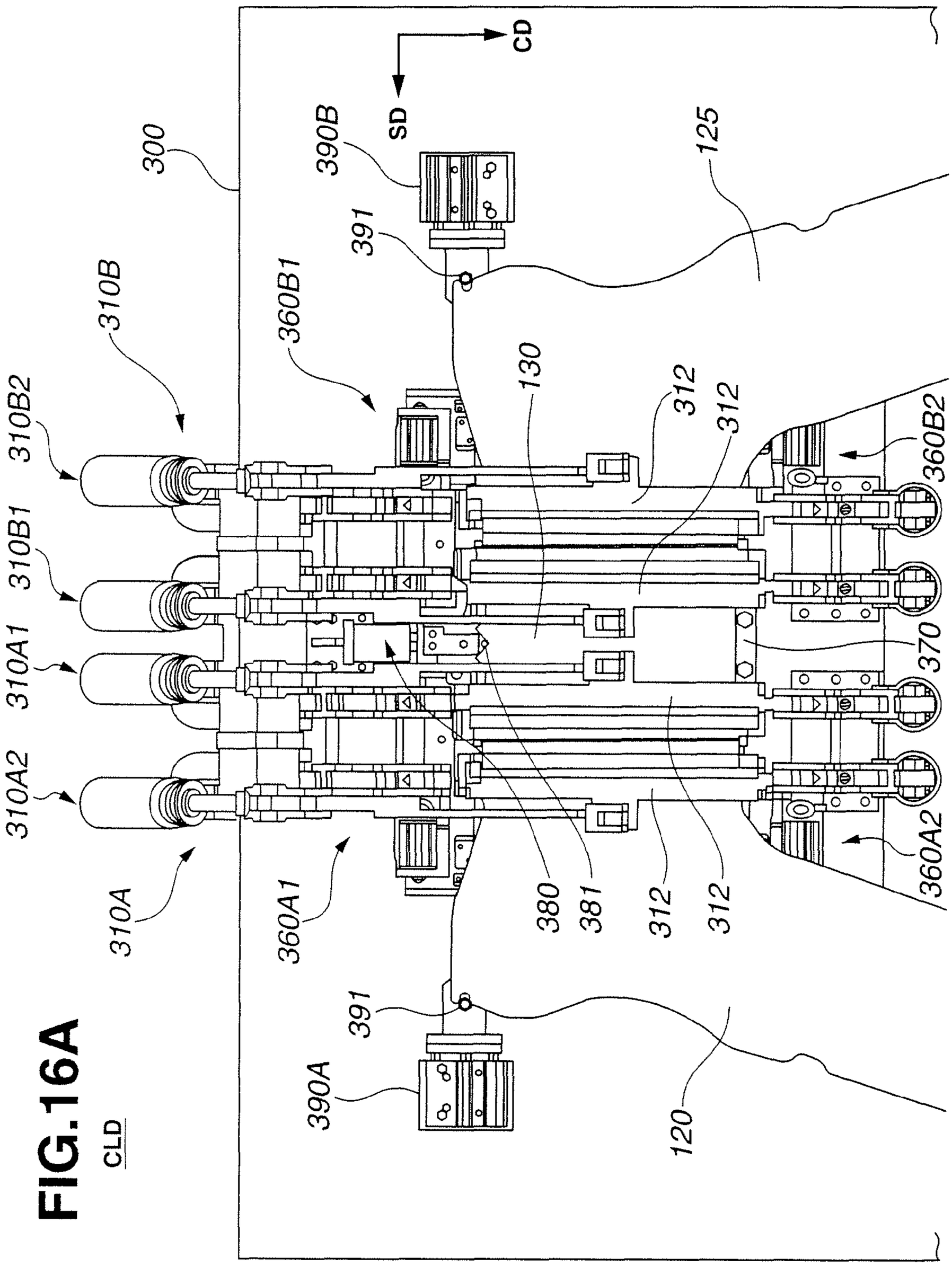
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360A2
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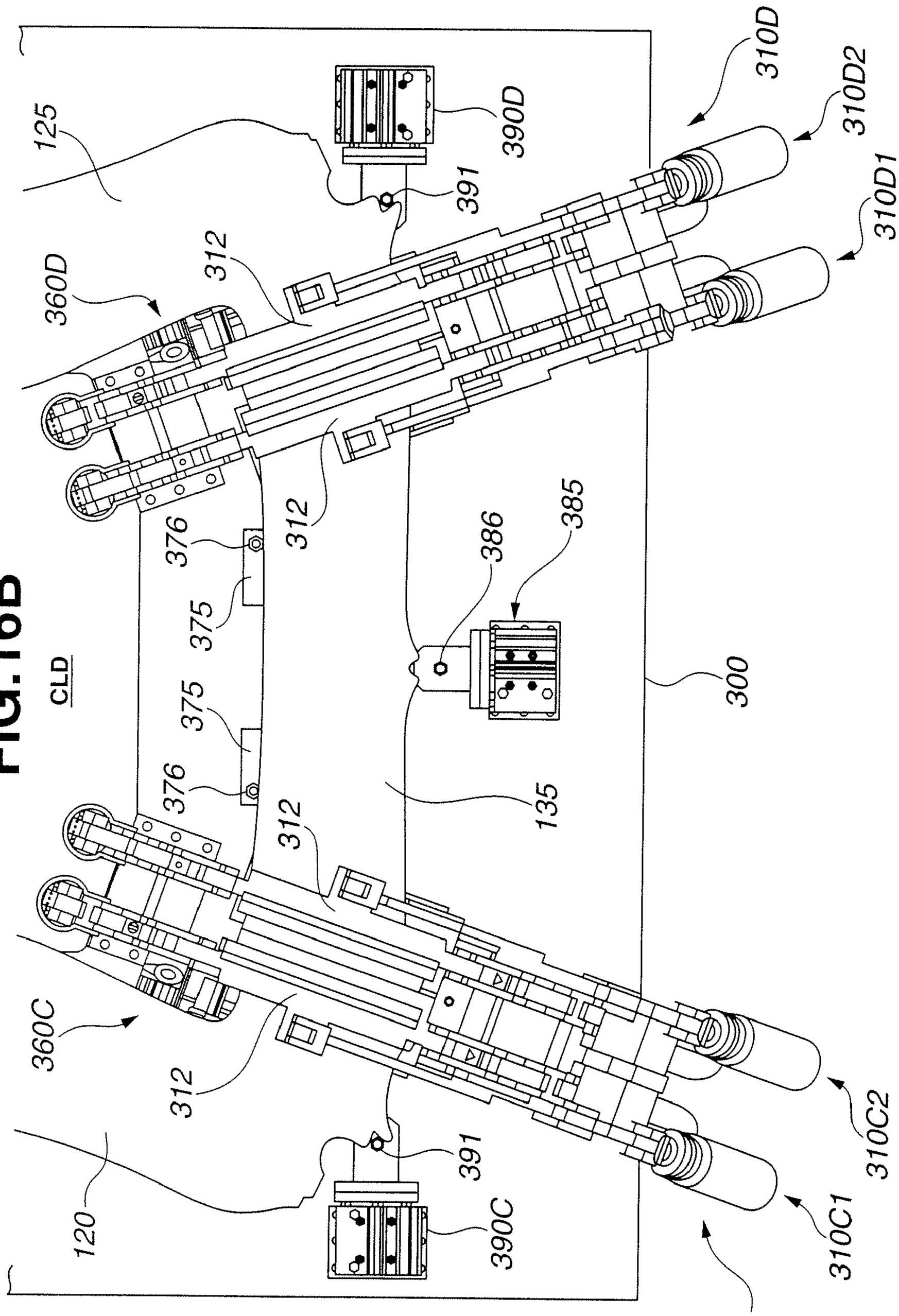
120
CLD

FIG.16A

FIG.16B


CLD
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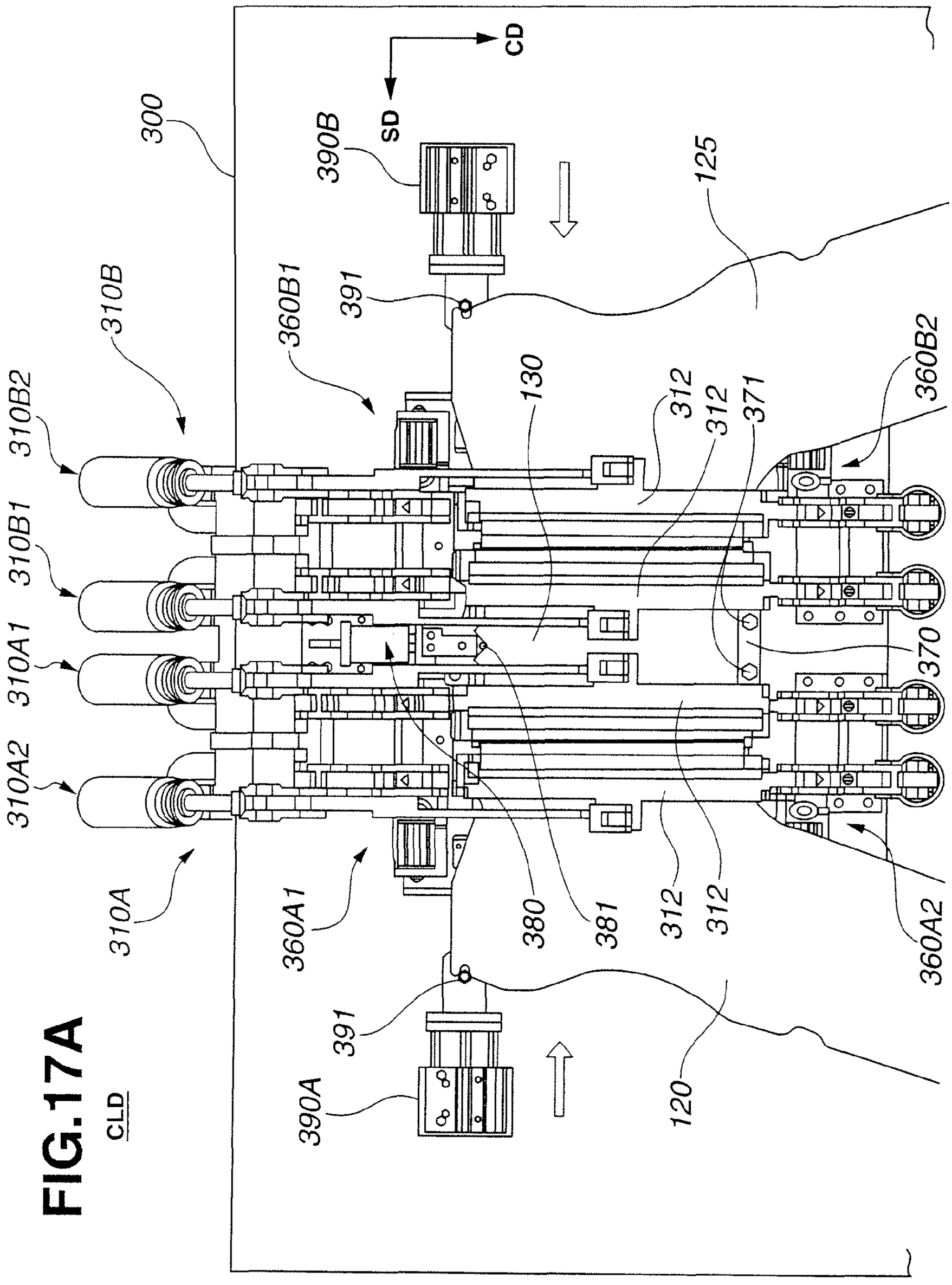
310C
310C1
310C2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310B2
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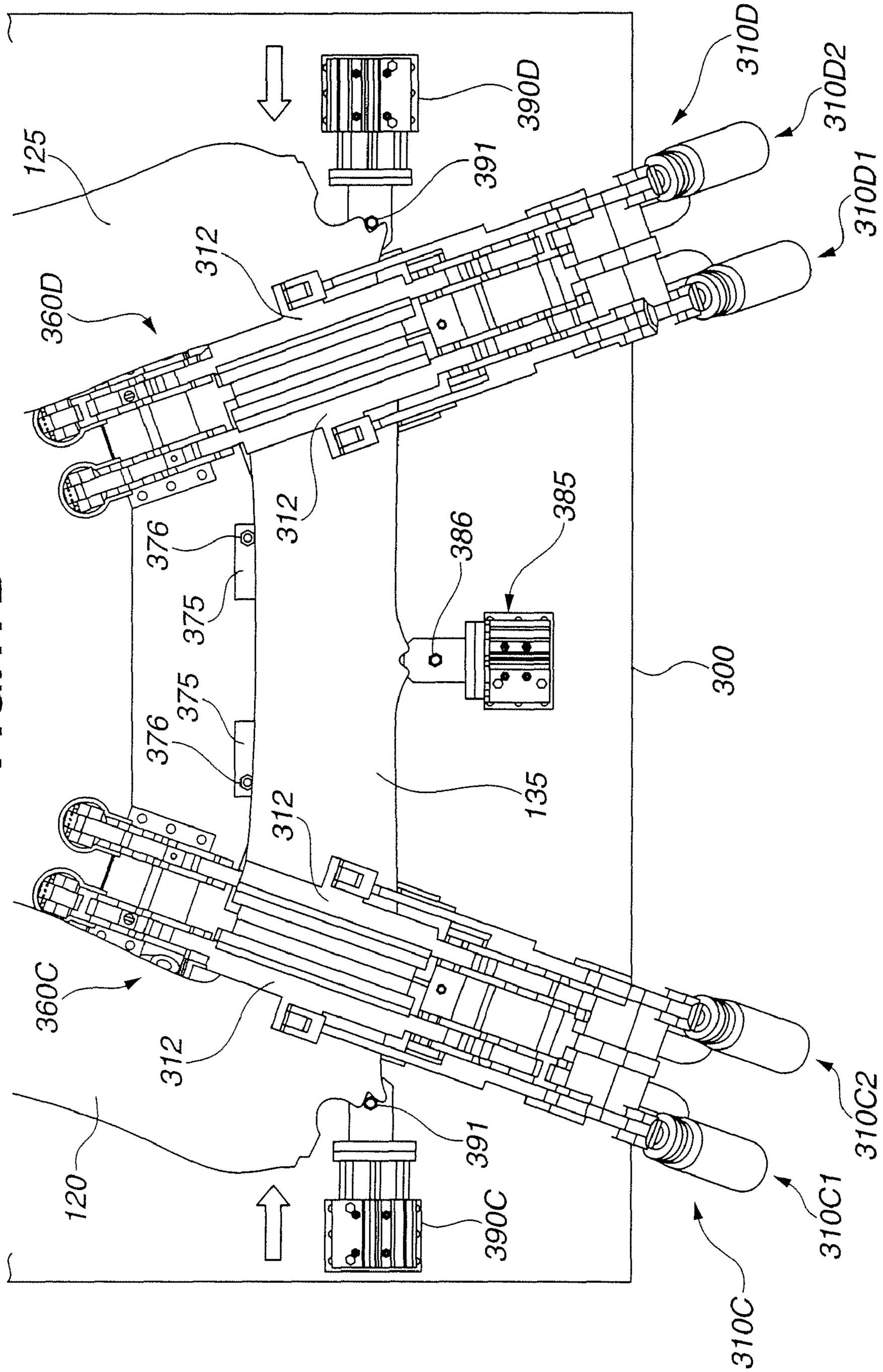
360A2
391
390A
120
CLD

FIG.17A

FIG.17B


125
390D
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310D
310D2
310D1
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360D
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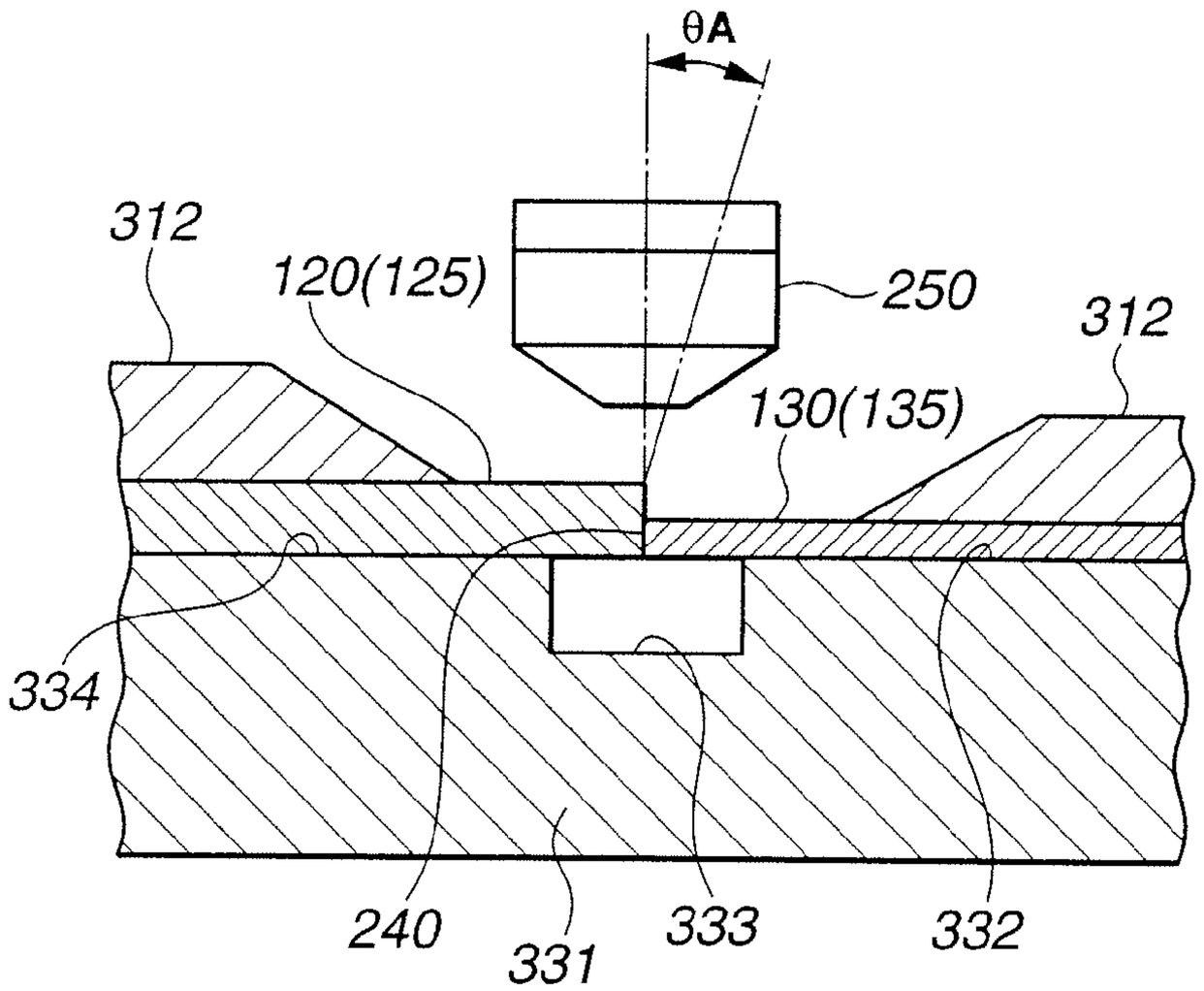
360C
312
120
391
390C
310C
310C1
310C2

FIG.18


θA
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120(125)
250
312
130(135)
334
240
331
333
332

FIG.19

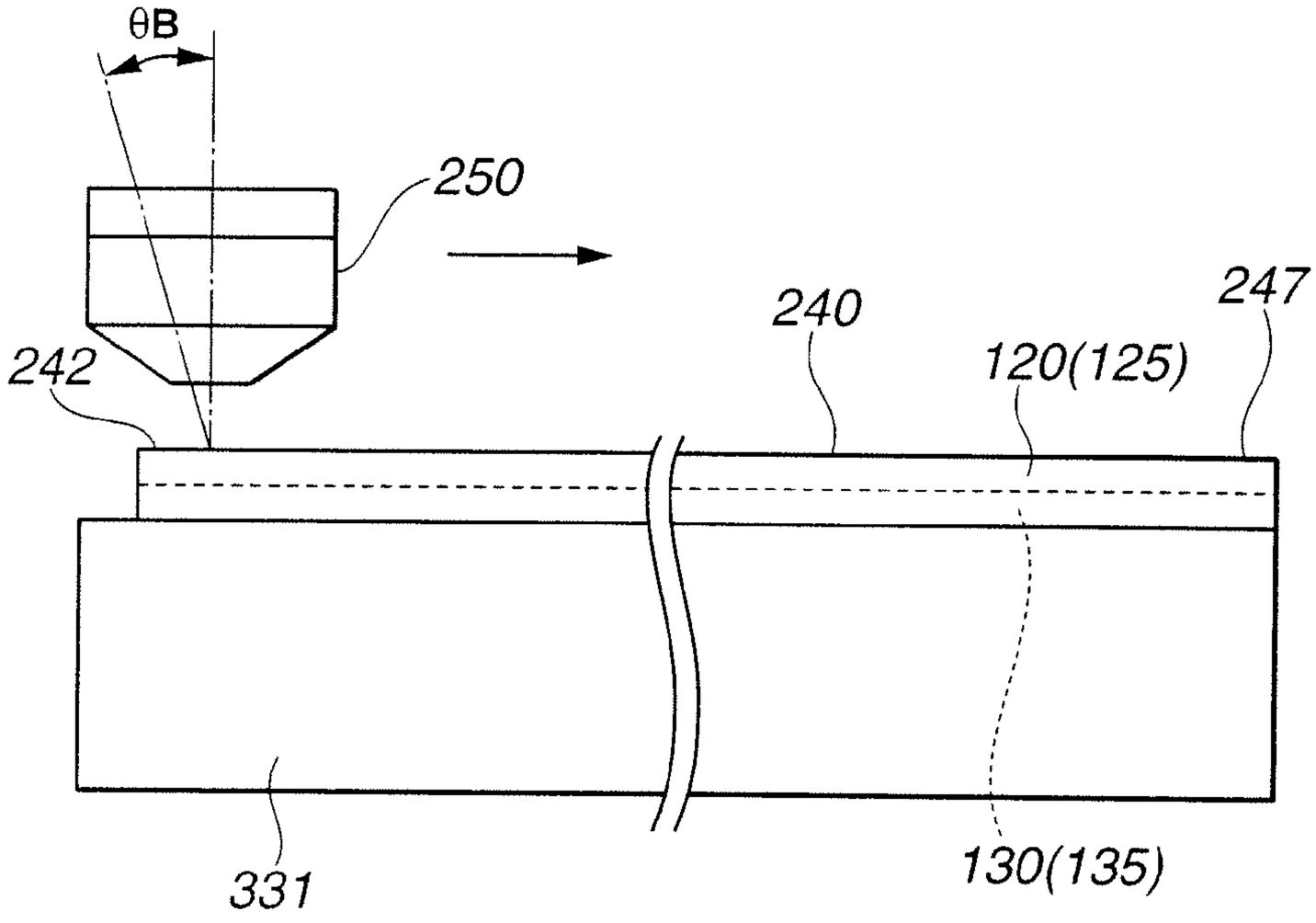

θB
250
242
240
247
120(125)
331
130(135)

FIG.20

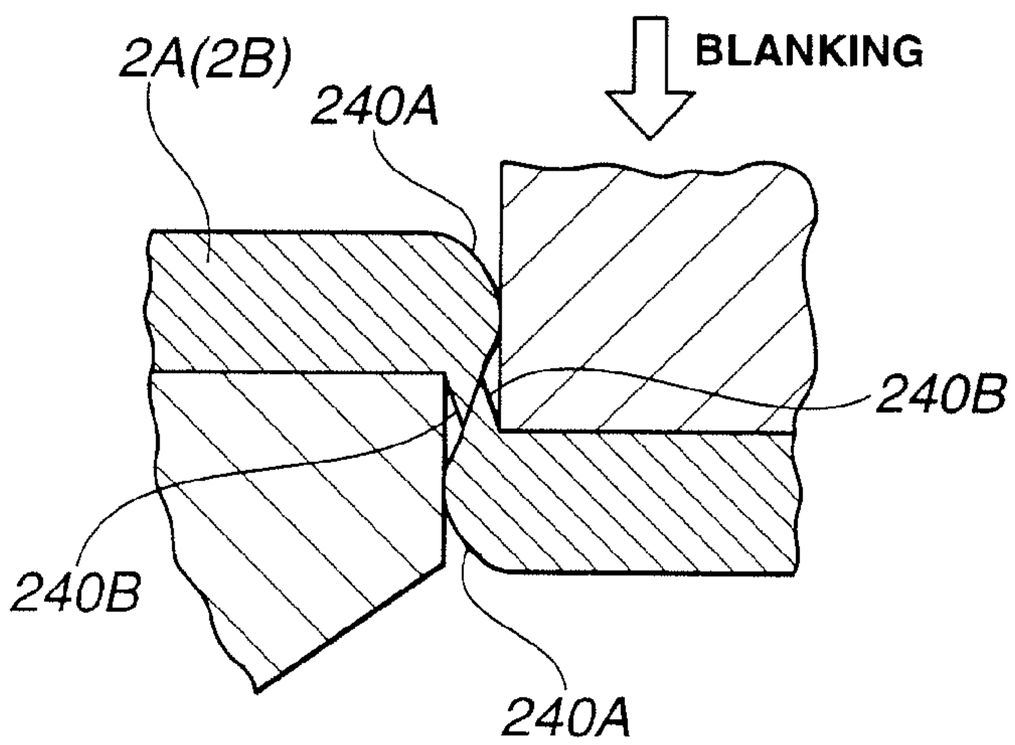


FIG.21A

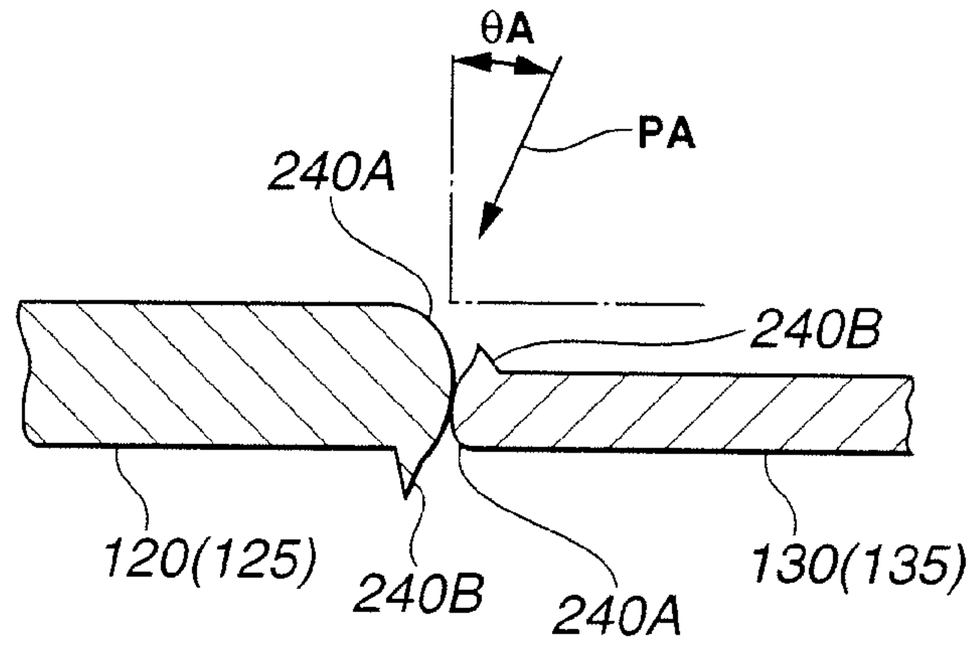
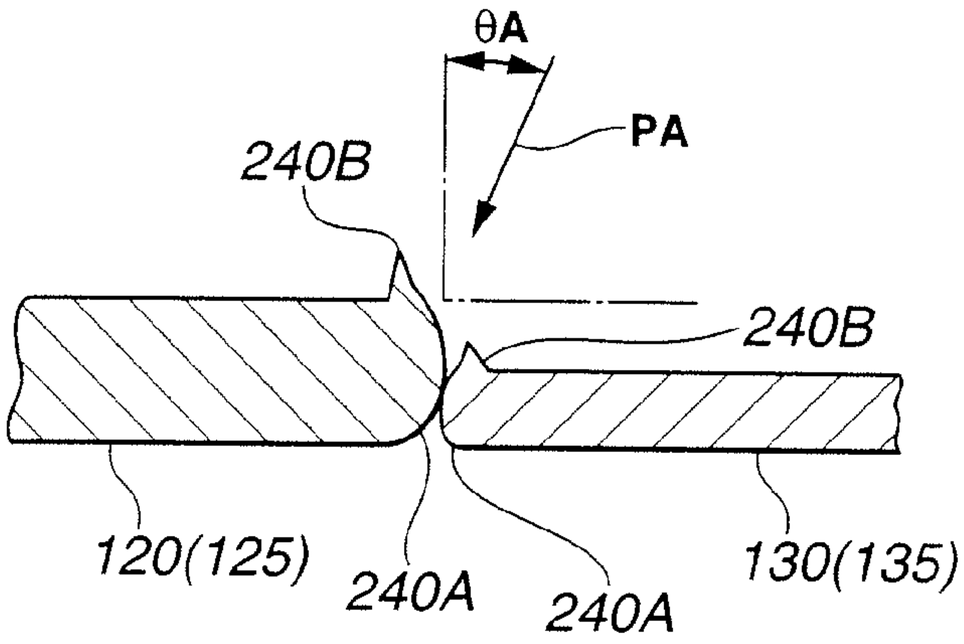


FIG.21B



CLAMP DEVICE

CROSS-REFERENCE TO RELATED PATENT APPLICATIONS

This application is a Continuation of U.S. application Ser. No. 11/085,050, filed Mar. 22, 2005, which is based upon and claims the benefit of priority from prior Japanese Patent Application No. 2004-106783, filed Mar. 31, 2004, the entire contents of all of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to clamp devices that clamp work pieces together, and more particularly to clamp devices of a type that clamps different types of blank pieces together for welding them to produce a tailored blank sheet. More specifically, the present invention is concerned with the clamp devices of a type that clamps a plurality of blank pieces in such a manner that every adjacent two of the blank pieces contact to each other at respective given edges thereof, in order to join thereafter the blank pieces together by applying a welding to the mutually contacting edges.

2. Description of the Related Art

Recently, particularly in the field of metal materials for wheeled motor vehicles, tailored blank sheets have been widely used, which are to be pressed to produce various parts of the motor vehicles. As is known, the tailored blank sheet is manufactured by welding different blank pieces at their mutually contacting edges. Actually, the different blank pieces are different in size, shape, thickness, strength, etc. The tailored blank sheet is ideal for the material for motor vehicle parts because of its wide applicability for the needs that the parts have, such as, reduction in weight and cost while keeping a satisfied mechanical strength of given portions. Some of such tailored blank sheets are shown in Japanese Laid-open Patent Applications (Tokkaihei) 10-180470, 11-104750 and (Tokkai) 2003-19516.

SUMMARY OF THE INVENTION

Hitherto, in the field of manufacturing the tailored blank sheets, various clamp devices have been proposed and put into practical use, which clamp different blank pieces together before welding the same at their mutually contacting edges. However, some of the known clamp devices have failed to exhibit a satisfied clamping function due to their inherent construction. That is, in such clamp devices, putting the different blank pieces onto a mounting table, moving these different blank pieces to respective proper positions on the mounting table and locking these different blank pieces at their proper positions have not been easily carried out. Actually, in such known clamp devices, these three operation steps, viz., the step for putting the blank pieces onto the mounting table, the step for moving the blank pieces to the respective positions and the step for locking the positioned blank pieces, are carried out in an unsystematic way needing futile interval steps. This reduces the productivity of product, viz., the tailored blank sheet and thus increases the cost of the same.

It is therefore an object of the present invention to provide a clamp device which is free of the above-mentioned drawbacks.

According to the present invention, there is provided a clamp device by which a step for putting different blank pieces onto a mounting table, a step for moving the blank pieces to respective proper positions on the mounting table and a step for locking the positioned flank pieces are carried out in a systematic way.

In accordance with a first aspect of the present invention, there is provided a clamp device for clamping different blank pieces, which comprises a mounting table having first and second mounting surfaces for placing thereon first and second ones of the different blank pieces respectively; a first clamping unit having a clamp plate that is able to be put on the first blank piece while permitting a guided movement of the first blank piece on the first mounting surface; a first positioning unit that moves the first blank piece in a first direction to establish a positioning of the first blank piece in the first direction; a second positioning unit that moves the first blank piece in a second direction to establish a positioning of the first blank piece in the second direction; a first lock unit that applies a given force to the clamp plate of the first clamping unit thereby to lock the first blank piece that has been positioned in the first and second directions; a second clamping unit having a clamp plate that is able to be put on the second blank piece while permitting a guided movement of the second blank piece on the second mounting surface; a third positioning unit that moves the second blank piece to a position where a given edge of the second blank piece is in contact with a given edge of the first blank piece that has been locked; and a second lock unit that applies a given force to the clamp plate of the second clamping unit thereby to lock the second blank piece that has been positioned by the third positioning unit.

In accordance with a second aspect of the present invention, there is provided a clamp device for clamping at least first and second blank pieces, which comprises a mounting table for placing thereon the first and second blank pieces; first and second clamping units having respective clamp plates that are able to be put on the first and second blank pieces while permitting a guided movement of the first and second blank pieces on the mounting table; positioning units that move the first and second blank pieces to establish a positioning of the first and second blank pieces on the mounting table; and lock units that apply a given force to the first and second clamp plates to lock the first and second blank pieces that have been positioned.

In accordance with a third aspect of the present invention, there is provided a method of clamping different blank pieces, which comprises placing first and second ones of the different blank pieces on first and second mounting surfaces respectively; putting a first clamp plate onto the first blank piece while permitting a guided movement of the first blank piece on the first mounting surface; moving the first blank piece in a first direction to establish a positioning of the first blank piece in the first direction; moving the first blank piece in a second direction to establish a positioning of the first blank piece in the second direction; applying a given force to the first clamp plate to lock the first blank piece that has been positioned in the first and second directions; putting a second clamp plate onto the second blank piece while permitting a guided movement of the second blank piece on the second mounting surface; moving the second blank place to a position where a given a given edge of the second blank piece is in contact with a give edge of the first blank piece that has been locked; and applying a given force to the second clamp plate to lock the second blank piece that has been positioned.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a suspension part of a motor vehicle, that is a tailored blank article produced by pressing a tailored blank sheet;

FIG. **2** is a perspective view of the tailored blank sheet that is to be pressed to produce the suspension part of FIG. **1**;

FIG. **3** is a conceptional view showing a step for blanking or stamping out four types of blank pieces from two coiled metal sheets by using two blanking machines, which are to be joined together to form the tailored blank sheet of FIG. **2**;

FIG. **4**A is a plan view of an upper half area of a clamp device according to the present invention, where two clamp units are arranged, each including inside and outside clamping units;

FIG. **4**B is a plan view of a lower half area of the clamp device of the present invention, where other two clamp units are arranged, each including inside and outside clamping units;

FIG. **5** is a side view of the clamp device of the present invention, that is taken from the direction of the arrow "V" of FIG. **4**A;

FIG. **6** is a plan view of one of the clamp units employed in the clamp device of the present invention, showing first and second mounting surfaces of a mounting table possessed by the clamp unit;

FIG. **7** is a view similar to FIG. **6**, but showing two clamp plates that are respectively put on the first and second mounting surfaces of the mounting table;

FIG. **8** is a view similar to FIG. **5**, but showing a condition wherein the clamp plate is put on the second mounting surface of the mounting table;

FIG. **9** is a view similar to FIG. **8**, but showing a condition wherein the clamp plate on the second mounting surface is kept locked;

FIG. **10** is a perspective view of a portion of the clamp device of the invention, where one positioning unit is arranged;

FIG. **11** is a view similar to FIG. **10**, but showing a different operation condition of the positioning unit;

FIG. **12** is a flowchart showing operation steps executed by the clamp device of the present invention;

FIGS. **13**A and **13**B are views similar to FIGS. **4**A and **4**B, but showing a condition wherein four different blank pieces (viz., left and right thicker blank pieces and upper and lower thinner blank pieces) are put on the four mounting tables and all of the clamp plates are opened or raised;

FIGS. **14**A and **14**B are views similar to FIGS. **13**A and **13**B, but showing a condition wherein the clamp plates for the upper and lower thinner blank pieces are put on these thinner blank pieces;

FIGS. **15**A and **15**B are views similar to FIGS. **14**A and **14**B, but showing a condition wherein the upper and lower thinner blank pieces are moved to be positioned with respect to the corresponding mounting tables;

FIGS. **16**A and **16**B are views similar to FIGS. **15**A and **15**B, but showing a condition wherein also the clamp plates for the left and right thicker blank pieces are put on these thicker blank pieces;

FIGS. **17**A and **17**B are views similar to FIGS. **16**A and **16**B, but showing a condition wherein the left and right thicker blank pieces are moved to be positioned with respect to the upper and lower thinner blank pieces that have been locked;

FIG. **18** is a schematically illustrated sectional view of a given part of the clamp device of the invention in a condition

wherein a welding is being applied to mutually contacting edges of the thicker and thinner blank pieces;

FIG. **19** is an enlarged side view of the given part of the clamp device of the present invention in the condition wherein the welding is being applied to the mutually contacting edges of the thicker and thinner blank pieces;

FIG. **20** is a sectional view of a part of the blanking machine showing a condition wherein a metal sheet is subjected to a blanking for producing blank pieces;

FIG. **21**A is a sectional view showing a condition wherein thicker and thinner blank pieces contact at their mutually facing edges; and

FIG. **21**B is a view similar to FIG. **21**A, but showing a condition wherein the thicker blank piece is left turned upside down.

DETAILED DESCRIPTION OF THE INVENTION

In the following, a clamp device "CLD" of the present invention will be described in detail with reference to the accompanying drawings.

For ease of understanding, various directional terms, such as, right, left, upper, lower, rightward and the like will be used in the following description. However, such terms are to be understood with respect to only drawing or drawings on which corresponding part or portion is shown.

As will become apparent as the description proceeds, the clamp device "CLD" according to the present invention is constructed to clamp four different blank pieces that are to be joined together to produce a tailored blank sheet that is to be pressed to produce a suspension part **10**.

Referring to FIG. **1**, there is shown the suspension part **10** for a motor vehicle, that is produced by pressing a tailored blank sheet **110** that is shown in FIG. **2**. An aluminum alloy sheet, a steel sheet and the like can be used as materials for the blank pieces for suspension part **10**.

As is seen from FIG. **1**, suspension part **10** shown comprises left and right side members **20** and **25** and upper and lower cross members **30** and **35**.

As shown, these four members **20**, **25**, **30** and **35** are the different blank pieces, each being blanked or stamped out from a metal sheet (see FIG. **3**). These four members **20**, **25**, **30** and **35** are integrally jointed together to constitute a generally trapezoidal frame like construction having a trapezoidal space "S" defined therein. Suspension part **10** has at its inner surface four rounded corners **21**, **21**, **26** and **26**.

Referring to FIG. **2**, there is shown the tailored blank sheet **110** that is to be pressed for producing the suspension part **10** of FIG. **1**.

Tailored blank sheet **110** shown in FIG. **2** comprises left and right thicker blank pieces **120** and **125** that correspond to the above-mentioned left and right side members **20** and **25** of FIG. **1**, upper and lower thinner blank pieces **130** and **135** that correspond to the above-mentioned upper and lower cross members **30** and **36** of FIG. **1**, and four welded portions **140** that tightly connect, by welding, mutually contacting edges of every neighboring two of thicker and thinner blank pieces **120**, **125**, **130** and **135**. As shown, tailored blank sheet **110** has a generally trapezoidal shape and has a trapezoidal space "S" defined therein. Tailored blank sheet **110** has at its inner periphery four bent portions **122**, **122**, **127** and **127**, and tailored blank sheet **110** has four corner portions **121**, **121**, **126** and **126**. It is to be noted that upon pressing of tailored blank sheet **110**, the inner bent portions **122**, **122**, **127** and **127** are formed into the above-mentioned four rounded corners **21**, **21**, **26** and **26** of suspension part **10** of FIG. **1**.

Referring to FIG. **3**, there is schematically shown a method of producing left and right thicker and upper and lower thinner blank pieces **120**, **125**, **130** and **130**. As shown, left and right thicker blank pieces **120** and **125** are blanked or stamped out from a thicker metal sheet **2**A by using a blanking machine **210**A, while upper and lower thinner blank pieces **130** and **135** are blanked or stamped out from a thinner metal sheet **2**B by using another blanking machine **210**B. For the reason that will be explained hereinlater, only three types of cutting dies are used for producing the four types of blank pieces **120**, **125**, **130** and **135**.

These four different blank pieces **120**, **125**, **130** and **135** are tightly clamped by the clamp device "CLD" of the present invention to assume their proper locked positions respectively for preparation of a subsequent welding process. That is, by the clamp device "CLD" of the invention, four different blank pieces **120**, **125**, **130** and **135** are stably placed or clamped on four mounting tables **331** in such an arrangement as shown by FIG. **2**.

Referring to FIGS. **4**A and **4**B, there is shown, in a plan view, the clamp device "CLD" according to the present invention. It is to be noted that FIG. **4**A shows an upper area of clamp device "CLD" where upper thinner blank piece **130** (see FIG. **2**) and its associated portions of left and right thicker blank pieces **120** and **125** are clamped, and FIG. **4**B shows a lower area of clamp device "CLD" where lower thinner blank piece **135** (see FIG. **2**) and its associated portions of left and right thicker blank pieces **120** and **125** are clamped.

As is seen from FIGS. **4**A and **4**B, clamp device "CLD" of the present invention generally comprises a tool base **300**, four clamp units **310**A, **310**B, **310**C and **310**D that are mounted on tool base **300**, and twelve positioning units **360**A**1**, **360**A**2**, **360**B**1**, **360**B**2**, **360**C, **360**D, **380**, **385**, **390**A, **390**B, **390**C, **390**D that are also mounted on tool base **300**.

As is understood from FIGS. **4**A and **13**A, clamp unit **310**A includes inside and outside identical clamping units **310**A**1** and **310**A**2**, the inside unit **310**A**1** being arranged to clamp a left part of upper thinner blank piece **130** and the outside unit **310**A**2** being arranged to clamp an upper part of left thicker blank piece **120**. Clamp unit **310**B includes inside and outside identical clamping units **310**B**1** and **310**B**2**, the inside unit **310**B**1** being arranged to clamp a right part of upper thinner blank piece **130** and the outside unit **310**B**2** being arranged to clamp an upper part of right thicker blank piece **125**.

While, as will be understood from FIGS. **4**B and **13**B, clamp unit **310**C includes inside and outside identical clamping units **310**C**1** and **310**C**2**, the inside unit **310**C**1** being arranged to clamp a left part of lower thinner blank piece **135** and the outside unit **310**C**2** being arranged to clamp a lower part of left thicker blank piece **120**. Clamp unit **310**D includes inside and outside identical clamping units **310**D**1** and **310**D**2**, the inside unit **310**D**1** being arranged to clamp a right part of lower thinner blank piece **135** and the outside unit **310**D**2** being arranged to clamp a lower part of right thicker blank piece **125**, as shown.

As will become apparent as the description proceeds, when left and right thicker and upper and lower thinner blank pieces **120**, **125**, **130** and **135** are properly clamped by the clamp device "CLD", mutually facing edges **240** of every neighboring two of blank pieces **120**, **125**, **130** and **135** are kept in contact with one another, as will be seen from FIGS. **17**A, **17**B and **18**.

As is seen from FIGS. **13**A and **4**A, the two positioning units **360**A**1** and **360**A**2** are positioned at a left side of clamp unit **310**A, which establish a positioning of a left edge of upper thinner blank piece **130** relative to its corresponding mounting table **331** and the other two positioning units **360**B**1** and **360**B**2** are positioned at a right side of clamp unit **310**B, which establish a positioning of a right edge of upper thinner blank piece **130** relative to its corresponding mounting table **331**, as will be described in detail hereinafter.

As is seen from FIGS. **13**B and **4**B, the positioning unit **360**C is positioned at a left side of clamp unit **310**C, which establishes a positioning of a left edge of lower thinner blank piece **135** relative to its corresponding mounting table **331** and the other positioning unit **360**D is positioned at a right side of clamp unit **310**D, which establishes a positioning of a right edge of lower thinner blank piece **135** relative to its corresponding mounting table **331**, as will be described in detail hereinafter.

As is understood from FIGS. **13**A and **4**A, positioning unit **380** is arranged at a middle position between clamp units **310**A and **310**B, which establishes a positioning of upper thinner blank piece **130** in a vertical direction in the drawings, that is, in the direction of the arrow "CD" of FIG. **4**A, as will be described in detail hereinafter.

While, as is seen from FIGS. **13**B and **4**B, the other positioning unit **385** is arranged at a middle position between clamp units **310**C and **310**D, which establishes a positioning of lower thinner blank piece **135** in a vertical direction in the drawings, that is, in the direction of the arrow "CD" of FIG. **4**B, as will be described in detail hereinafter.

As is seen from FIG. **4**A, positioning unit **380** comprises a hydraulic cylinder (no numeral), a positioning pin **381** driven by the hydraulic cylinder, a pin holder **370** and stopper pins **371** fixed to pin holder **370**.

As is seen from FIG. **4**B, positioning unit **385** comprises a hydraulic cylinder (no numeral), a positioning pin **386** driven by the hydraulic cylinder, a pin holder **375** and stopper pins **376** fixed to pin holder **375**.

That is, as will be described in detail hereinafter, upon energization of the hydraulic cylinders, positioning pins **381** and **386** are brought into contact with upper and lower thinner blank pieces **130** and **135** and move the same toward the associated stopper pins **371** and **376**. With this, positioning of upper and lower thinner blank pieces **130** and **135** in the direction of the arrow "CD" is established.

As is seen from FIGS. **4**A and **4**B, the four positioning units **390**A, **390**B, **390**C and **390**D are arranged outside of clamp units **310**A, **310**B, **310**C and **310**D to establish a positioning of left and right thicker blank pieces **120** and **125** in a lateral direction in the drawings, that is, in the direction of the arrow "SD" of FIGS. **4**A and **4**B.

The two positioning units **390**A and **390**C are arranged to handle the left thicker blank piece **120**, while the other two positioning units **390**B and **390**D are arranged to handle the right thicker blank piece **125**.

As is seen from the drawings, each positioning unit **390**A, **390**B, **390**CB or **390**D comprises a positioning pin **391** that is to be in contact with an outer edge of left or right thicker blank piece **120** or **125** and a hydraulic cylinder (no numeral) that drives or moves positioning pin **391** with a hydraulic power.

That is, upon energization of the hydraulic cylinders, positioning pins **391** of the four positioning units **390**A, **390**B, **390**C and **390**D are brought into contact with left and right thicker blank pieces **120** and **125** and move the same inwardly, that is, toward upper and lower thinner blank pieces **130** and **135**.

In the following, clamp units **310**A, **310**B, **310**C and **310**D will be described in detail with reference to FIGS. **5**, **6**, **7**, **8** and **9**.

FIGS. **5**, **8** and **9** show side views of clamp unit **310**A. It is to be noted that these side views of clamp unit **310**A are taken from the direction of the arrow "V" of FIG. **4**A.

As has been mentioned hereinabove, each clamp unit, for example, the clamp unit **310**A includes inside and outside identical clamping units **310**A**1** and **310**A**2**. Inside clamping unit **310**A**1** is arranged to clamp a left part of upper thinner blank piece **130** and outside clamping unit **310**A**2** is arranged to clamp an upper part of left thicker blank piece **120**.

As is seen from FIGS. **5** and **4**A, each clamp unit **310**A (**310**B, **310**C or **310**D) comprises a mounting table **331** on which first and second mounting surfaces **332** and **334** are formed.

As is understood from FIGS. **5** and **6**, mounting table **331** has first and second mounting surfaces **332** and **334** which are rectangular in shape and constitute a fixed mounting surface. Between first and second mounting surfaces **332** and **334**, there is defined a groove **333**.

As will be understood from FIG. **6**, in case of clamp unit **310**A, first mounting surface **332** serves to put thereon a left part of upper thinner blank piece **130** and second mounting surface **334** serves to put thereon an upper part of left thicker blank piece **120**.

While, as is understood from FIG. **13**A, in case of clamp unit **310**B, first mounting surface **332** serves to put thereon a right part of upper thinner blank piece **130** and second mounting surface **334** serves to put thereon an upper part of right thicker blank piece **125**. As is seen from **13**B, in case of clamp unit **310**C, first and second mounting surfaces **332** and **334** serve to put thereon a left part of lower thinner blank piece **135** and a lower part of left thicker blank piece **120** respectively, and in case of clamp unit **310**D, first and second mounting surfaces **332** and **334** serve to put thereon a right part of lower thinner blank piece **135** and a lower part of right thicker blank piece **125** respectively.

As is seen from FIG. **4**A, beside second mounting surface **334** of clamp unit **310**A or **310**B, there are arranged the positioning units **360**A**1** and **360**A**2** (or **360**B**1** and **360**B**2**). While, as is seen from FIG. **4**B, beside second mounting surface **334** of clamp unit **310**C or **310**D, there is arranged the positioning unit **360**C or **360**D. As shown in these drawings, viz., FIGS. **4**A and **4**B, the size of second mounting surface **334** is smaller than that of first mounting surface **332**.

As is best seen from FIG. **6**, between first and second rectangular mounting surfaces **332** and **334**, there is defined the groove **333** over which mutually facing edges of thicker and thinner blank pieces **120** and **130** (**125** and **130**, **120** and **135**, or **125** and **135**) are to be brought into contact with each other for preparation of a subsequent welding process.

As is seen from FIGS. **13**A and **4**A and as will become apparent as the description proceeds, at an initial stage of operation of the clamp device "CLD", the left and right parts of upper thinner blank piece **130** are put on respective first mounting surfaces **332** of the mounting tables **331** of respective clamp units **310**A and **310**B, the upper part of left thicker blank piece **120** is put on second mounting surface **334** of the mounting table **331** of clamp unit **310**A and the upper part of right thicker blank piece **125** is put on second mounting surface **334** the mounting table **331** of clamp unit **310**B, and as is seen from FIGS. **13**B and **4**B and as will become apparent hereinafter, at the initial stage of operation of the clamp device "CLD", lateral end portions of lower thinner blank piece **135** are put on respective first mounting surfaces **332** of the mounting tables **331** of positioning units **360**C and **360**D, the lower part of left thicker blank piece **120** is put on second mounting surface **334** of the mounting table **331** of positioning unit **360**C and the lower part of right thicker blank piece **125** is put on second mounting surface **334** of the mounting table **331** of positioning unit **360**D.

W the positioning of the four blank pieces **120**, **125**, **130** and **135** is completed, mutually contacting edges of every neighboring two of thicker and thinner blank pieces **120**, **125**, **130** and **135** are placed over the corresponding grooves **333**.

As is seen from FIGS. **5** and **6**, each clamping unit **310**A**1** or **310**A**2** of each clamp unit **310**A (**310**B, **310**C or **310**D) comprises generally a clamp plate **312**, a hydraulic cylinder **319** and an arm member **314** that operatively connects hydraulic cylinder **319** and arm member **314**.

As shown in FIG. **5**, a lower portion of arm member **314** has a bracket **315** fixed thereto, and bracket **315** is pivotally connected to a fixed frame portion of clamp unit **310**A through a pivot pin **316**. A lower end of arm member **314** is pivotally connected to a piston rod **318** of hydraulic cylinder **319** through a pivot pin **317**, and an upper end of arm member **314** is pivotally connected to an intermediate portion of clamp plate **312** through a pivot pin **313**.

Thus, upon energization of hydraulic cylinder **319**, piston rod **318** is pushed upward in FIG. **5** thereby to pivot arm member **314** in a clockwise direction about pivot pin **316**. With this, as is seen from FIG. **7**, in case of clamping units **310**A**1** and **310**A**2** of clamp unit **310**A, respective clamp plates **312** are pivoted down onto first and second mounting surfaces **332** and **334** of the mounting table **331**. Thus, when the upper part of left thicker blank piece **120** is placed on second mounting surface **334** and the left part of upper thinner blank piece **130** is placed on first mounting surface **332**, such parts of the blank pieces **120** and **130** are pressed or clamped by the respective clamp plates **312** respectively. It is to be noted that, as is understood from FIG. **4**A, the right part of upper thinner blank piece **130** and the upper part of right thicker blank piece **125** are respectively pressed or clamped by clamp plates **312** of clamp unit **310**B, and as is understood from FIG. **4**B, the lower part of left thicker blank piece **120** and the left part of lower thinner blank piece **135** are pressed or clamped by respective clamp plates **312** of clamp unit **310**C, and as is understood from the same drawing, the lower part of right thicker blank piece **125** and the right part of lower thinner blank piece **135** are pressed or clamped by respective clamp plates **312** of clamp unit **310**D.

For assuring the pressing of clamp plates **312** relative to thicker and thinner blank pieces **120**, **125**, **130** and **135**, each clamp plate **312** can be locked by an action of a lock mechanism.

It is to be noted that the lock mechanism is provided for each clamp plate **312**. Since the lock mechanisms of the clamp units **310**A, **310**B, **310**C and **310**D are substantially same in construction, the following description will be directed to only the lock mechanism for the clamp plate **312** that is to be pivoted onto second mounting surface **334** of clamp unit **310**A (see FIG. **4**A).

As is seen from FIG. **5**, the lock mechanism generally comprises left and right locking pawls **341** and **351**, left and right hydraulic cylinders **349** and **359**, a first left link **344**, a second left link **345**, a first right link **354** and a second right link **355**. Left locking pawl **341** is pivotally connected to a piston rod **348** of left hydraulic cylinder **349** through first left link **344**, second left link **345** and a pivot pin **347** by which second left link **345** and piston rod **348** are pivotally connected. Left locking pawl **341** is pivotally connected to a fixed frame member **346** through a pivot pin **346**A, and second left link **345** is pivotally connected through a pivot pin **346**B to the fixed frame member **346**. Right locking pawl **351** is pivotally connected to a piston rod **358** of right hydraulic cylinder **359** through first right link **354**, second right link **355** and a pivot pin **357** through which second right link **355** and piston rod **358** are pivotally connected. Right locking pawl **351** is piv-

otally connected through a pivot pin **356**A to a fixed frame member **356**, and second right link **355** is pivotally connected through a pivot pin **356**B to the fixed frame member **356**.

Each locking pawl **341** or **351** has a generally V-shaped recess of which opposed inner surfaces are formed with opposed first and second projections **342** and **343** (or **352** and **353**) respectively.

First projection **342** or **352** has a generally rectangular top surface that is sized and arranged to receive a reduced side edge **312**A of clamp plate **312**. When, with left thicker part blank piece **120** being put on second mounting surface **334**, the corresponding clamp plate **312** is put onto the top surfaces of first projections **342** and **352**, there is defined a thin clearance between an upper surface of left thicker blank piece **120** and a lower surface of the clamp plate **312**. Accordingly, even under such condition, movement of left thicker blank piece **120** on the second mounting surface **332** is permitted. It is however to be noted that the thickness of the clearance should be smaller than the thickness of upper and lower thinner blank pieces **130** and **135**.

Second projection **343** or **353** has a generally triangular cross section and is able to abut on an upper surface of the reduced side edge **312**A of clamp plate **312** that is held on first projections **342** and **352**. Thus, when left and right locking pawls **341** and **351** are pivoted inside, clamp plate **312** is pressed against the upper part of left thicker blank piece **120** on second mounting surface **334**. Although not shown in the drawings, reduced side edge **312**A is formed with two positioning recesses into which second projections **343** and **353** are received when left and right locking pawls **341** and **351** are pivoted in the locking direction.

That is, when hydraulic cylinders **349** and **359** are energized, piston rods **348** and **358** are pushed upward. With this, left and right locking pawls **341** and **351** are pivoted clockwise and counterclockwise respectively about respective pivot pins **346**A and **356**A. With this, as is seen from FIG. **9**, reduced side edge **312**A of clamp plate **312** can be locked by left and right locking pawls **341** and **351**.

Referring back to FIG. **5**, the lock mechanism further has, for each locking pawl **341** or **351**, a clamp plate guide **336**, a forward movement stopper **337** and a rearward movement stopper **338**. Clamp plate guide **336** is mounted on the fixed frame member to properly guide the downward movement of clamp plate **312** onto second mounting surface **334**. Forward movement stopper **337** is mounted on the fixed frame member at a position to contact an upper portion of second link **345** or **355** thereby to stop an excessive downward pivoting of second link **345** or **355**, and rearward movement stopper **338** is mounted on the fixed frame member at a position to contact a lower portion of second link **345** or **355** thereby to set an initial position of second link **345** or **355**. By varying the position of rearward movement stopper **338**, the clearance that is to be defined between clamp plate **312** and the upper part of left thicker blank piece **120** can be adjusted.

The construction of six positioning units **360**A**1**, **360**A**2**, **360**B**1**, **360**B**2**, **360**C and **360**D will be much clearly understood from the following description that is directed to positioning unit **360**A**1** that positions the left part of upper thinner blank piece **130** relative to first mounting surface **332** of positioning unit **360**A**1**. Since the other positioning units **360**A**2**, **360**B**1**, **360**B**2**, **360**C and **360**D are substantially the same in construction as the unit **360**A**1**, description of such units **360**A**2**, **360**B**1**, **360**B**2**, **360**C and **360**D will be omitted.

The description on positioning unit **360**A**1** will be made in the following with reference to FIGS. **10** and **11**.

As is seen from FIG. **10**, positioning unit **360**A**1** is arranged beside clamp unit **310**A and comprises an inclined hydraulic cylinder **368** that is connected to a fixed frame member of clamp device "CLD". Connected to a side wall of hydraulic cylinder **368** is a guide casing **365** that has a sliding rod **364** slidably disposed therein. Although not shown in the drawing, a piston in hydraulic cylinder **368** is connected to sliding rod **364** through a connecting link. With this, movement of the piston in hydraulic cylinder **368** induces movement of sliding rod **364** in the guide casing **365**. Sliding rod **364** has at its top a pin holder **361** connected thereto. Pin holder **361** has a positioning pin **362** connected to a top thereof. Denoted by numeral **367** is a position adjuster that can adjust the position of positioning unit **360**A**1** relative to the tool base **300**. Denoted by numeral **366** is a stopper that can suppress an excessive displacement of positioning unit **360**A**1** by position adjuster **367**.

That is, when hydraulic cylinder **368** is energized, sliding rod **364** connected to the piston of the cylinder **368** is slid obliquely upward in guide casing **365** thereby moving positioning pin **362** in the same direction. During this, positioning pin **362** is moved in the same direction, and when sliding rod **364** takes its uppermost position, positioning pin **362** assumes a position where a front edge thereof is placed at a middle position of groove **333** defined between first and second rectangular mounting surfaces **332** and **334**. Thus, if the left part of upper thinner blank piece **130** is roughly placed on first mounting surface **332**, the upward movement of sliding rod **364** brings about abutment of positioning pin **362** with an edge of the left part of upper thinner blank piece **130** to push the same, and finally places the edge of the left part of upper thinner blank piece **130** at the middle position of groove **333**.

As will be understood from FIG. **4**A, positioning unit **360**A**2** that is a partner of the above-mentioned positioning unit **360**A**1** is arranged at an opposite side of the unit **360**A**1**, which has substantially the same construction as the unit **360**A**1**. Thus, if upper thinner blank piece **130** is roughly placed on first mounting surfaces **332** of clamp units **310**A and **310**B (see FIG. **4**A), synchronous upward movement of two positioning pins **362** of the two units **360**A**1** and **360**A**2** finally places the left edge of upper thinner blank piece **130** at the middle position of groove **333**.

In the following, operation of the clamp device "CLD" of the present invention will be described with reference to the flowchart of FIG. **12** and other drawings.

As has been mentioned hereinabove, four types of blank pieces **120**, **125**, **130** and **135** are produced by blanking two metal sheets, as is shown in FIG. **3**.

For ease of understanding, the description on operation will be commenced with respect to a stand-by condition of the clamp device "CLD". In this condition, all (viz., eight) of clamp plates **312** are kept opened or raised.

At step S-**1**, four blank pieces **120**, **125**, **130** and **135** are put onto the four mounting tables **331** (see FIG. **5**) by using, for example, a handling robot (not shown). Upon this, as is understood from FIGS. **13**A and **13**B, left and right parts of upper thinner blank piece **130** are placed on respective first mounting surfaces **332** of clamp units **310**A and **310**B, left and right lower thinner blank piece **135** are placed on respective first mounting surfaces **332** of clamp units **310**C and **310**D, upper and lower parts of left thicker blank piece **120** are placed on respective second mounting surfaces **334** of clamp units **310**A and **310**C, and upper and lower parts of right thicker blank piece **125** are placed on respective second mounting surfaces **334** of clamp units **310**B and **310**D. That is, four blank pieces **120**, **125**, **130** and **135** are laid on first and second mounting surfaces **332** and **334** of the four mounting tables **331** in such a manner as to constitute a trapezoidal shape, as may be easily understood from the drawings.

Then, at step S-**2**, as is seen from FIGS. **14**A and **14**B, the inside two clamp plates **312** for upper thinner blank piece **130** and the inside two clamp plates **312** for lower thinner blank piece **135** are pivoted down and put on their corresponding blank pieces **130** and **135**. Upon this, as has been mentioned hereinabove and as is seen from FIG. **8**, projections **342** and **352** of the four pairs of locking pawls **341** and **351** support the reduced side edges **312**A of the four clamp plates **312**. As is understood from the drawing, there is defined a certain clearance between an upper surface of upper or lower thinner blank piece **130** or **135** and a lower surface of the corresponding clamp plate **312**. Due to provision of such clearance, upper thinner blank piece **130** and lower thinner blank piece **135** are permitted to move on their corresponding first mounting surfaces **332** while being guided by the corresponding clamp plates **312**.

Then, at step S-**3**, as is seen from FIGS. **15**A and **15**B, positioning of upper and lower thinner blank pieces **130** and **135** in the direction of the arrow "CD" is carried out. That is, at this step S-**3**, positioning units **380** and **385** are energized. As shown in the drawings, upon energization of positioning unit **380**, positioning pin **381** of the unit **380** is brought into abutment with an upper edge of upper thinner blank piece **130** to push the same toward the stopper pins **371**, and upon energization of positioning unit **385**, positioning pin **386** of the unit **385** is brought into abutment with a lower edge of lower thinner blank piece **135** to push the same toward the stopper pins **376**. With this, positioning of upper and lower thinner blank pieces **130** and **135** in the direction of the arrow "CD" is established.

Then, at step S-**4**, positioning of upper and lower thinner blank pieces **130** and **135** in the direction of the arrow "SD" is carried out. That is, at this step S-**4**, six positioning units **360**A**1**, **360**A**2**, **360**B**1**, **360**B**2**, **360**C and **360**D are energized. Upon energization of the four positioning units **360**A**1**, **360**A**2**, **360**B**1** and **360**B**2**, upper thinner blank piece **130** is moved but slightly in the above-mentioned manner and finally positioned with respect to the two grooves **333** each being defined between first and second mounting surfaces **332** and **334**, as is seen from FIG. **15**A, and upon energization of the remaining two positioning units **360**C and **360**D, lower thinner blank piece **135** is moved but slightly in the above-mentioned manner and finally positioned with respect to the two grooves **333** each being defined between first and second mounting surfaces **332** and **334**, as is seen from FIG. **15**B. That is, in this case, lateral edges of upper thinner blank piece **130** are each placed at the middle position of the corresponding groove **333**, and also lateral edges of lower thinner blank piece **135** are each placed at the middle position of the corresponding groove **333**. Positioning of upper and lower thinner blank pieces **130** and **135** is thus accomplished.

This step S-**4** will be much clearly understood when taken in conjunction with FIGS. **10** and **11**. Actually, movement of upper and lower thinner blank pieces **130** and **135** in the direction of the arrow "SD" is made by positioning pins **362** of positioning units **360**A**1**, **360**A**2**, **360**B**1**, **360**B**2**, **360**C and **360**D.

Then, at step S-**5**, locking of upper and lower thinner blank pieces **130** and **135** is carried out. That is, at this step S-**5**, as is seen from FIG. **9**, the two pairs of locking pawls **341** and **351** for the inside two clamp plates **312** for upper thinner blank piece **130** and the two pairs of locking pawls **341** and **351** for the inside two clamp plates **312** for lower thinner blank piece **135** are pivoted inside by the force of the corresponding hydraulic cylinders **349** and **359**. With this, projections **343** and **353** of the locking pawls **341** and **351** for the inside two clamp plates **312** for upper thinner blank piece **130** and those **343** and **353** of the locking pawls **341** and **351** for the inside two clamp plates **312** for lower thinner blank piece **135** are pressed against the reduced side edges **312**A of the corresponding clamp plates **312**. With this step, upper and lower thinner blank pieces **130** and **135** are locked at their proper positions.

Then, at step S-**6**, as is seen from FIGS. **16**A and **16**B, the outside two clamp plates **312** for respective upper parts of left and right thicker blank pieces **120** and **125** and outside two clamp plates **312** for respective lower parts of left and right thicker blank pieces **120** and **125** are pivoted down to be put on their corresponding blank pieces **120** and **125**. Upon this, as has been mentioned hereinabove and as is understood from FIG. **8**, projections **342** and **352** of the four pairs of locking pawls **341** and **351** support the reduced side edges **312**A of the four clamp plates **312**. Under this condition, there is defined a certain clearance between an upper surface of each of left and right thicker blank pieces **120** and **125** and a lower surface of the corresponding clamp plate **312**. Due to provision of such clearance, left and right thicker blank pieces **120** and **125** are permitted to move on their corresponding second mounting surfaces **334** while being guided by the corresponding clamp plates **312**.

Then, at step S-**7**, as is seen from FIGS. **17**A and **17**B, positioning of left and right thicker blank pieces **120** and **125** in the direction of the arrow "SD" is carried out. That is, at this step S-**7**, four positioning units **390**A, **390**B, **390**C and **390**D are energized. As shown in the drawings, upon energization of positioning units **390**A and **390**C, respective positioning pins **391** press left thicker blank piece **120** rightward, and upon energization of positioning units **390**B and **390**D, respective positioning pins **391** press right thicker blank piece **125** leftward. Due to this operation, each of left and right thicker blank pieces **120** and **125** is brought into contact with both the locked upper and lower thinner blank pieces **130** and **135** at their mutually facing edges. That is, in this condition, positioning of left and right thicker blank pieces **120** and **125** is established.

Then, at step S-**8**, locking of left and right thicker blank pieces **120** and **125** is carried out. That is, at this step S-**8**, as is understood from FIG. **9**, the two pairs of locking pawls **341** and **351** for the outside two clamp plates **312** for left thicker blank piece **120** and the two pairs locking pawls **341** and **351** for the outside two clamp plates **312** for right thicker blank piece **125** are turned inside by the force of the corresponding hydraulic cylinders **349** and **359**. With this, projections **343** and **353** of the locking pawls **341** and **351** for the outside two clamp plates **312** for left thicker blank piece **120** and those **343** and **353** of the locking pawls **341** and **351** for the outside two clamp plates **312** for right thicker blank piece **125** are pressed against the reduced side edges **312**A of the corresponding clamp plates **312**. With this step, left and right thicker blank pieces **120** and **125** are locked at their proper positions.

Thereafter, four positioning units **390**A, **390**B, **390**C and **390**D are deenergized for moving back positioning pins **391** to their rest positions.

With the above-mentioned steps, the four blank pieces **120**, **125**, **130** and **135** are locked at their proper positions. Under this locked condition, the mutually contacting edges **240** of every neighboring two of thicker and thinner blank pieces **120**, **125**, **130** and **135** are placed at and above the middle position of the corresponding groove **333** (see FIG. **18**).

For producing the tailored blank sheet **110** as shown in FIG. **2**, the mutually contacting edges **240** of the four blank pieces **120**, **125**, **130** and **135** are subjected to a plasma spraying welding for welding thereof. Of course, a laser beam

welding, an electron beam welding and the like are also usable for welding such contacting edges **240**. With this welding, the four blank pieces **120**, **125**, **130** and **135** are joined together to constitute the tailored blank sheet **110** of FIG. **2**. The tailored blank sheet **110** is then subjected to a press forming to produce a finished product, that is the suspension part **10** of a motor vehicle as shown in FIG. **1**.

In the following, the plasma spraying welding will be described with reference to FIGS. **18** and **19**.

For carrying out such welding, an arc torch **250** is used from which a plasma arc is jetted. Usually, arc torch **250** comprises a first gas passage through which a plasma gas flows, a second gas passage through which a gas for sealing the welded portion flows and a negative electrode (cathode). The plasma gas is argon, and the sealing gas is a mixture of argon and hydrogen gas.

As is seen from FIG. **18**, thinner blank piece **130** (or **135**) and thicker blank piece **120** (or **125**) are respectively placed on first and second mounting surfaces **332** and **334** with their mutually facing edges **240** kept in contact with each other. Denoted by numeral **333** is the groove of mounting table **331** over which the mutually contacting edges **240** are positioned. Thinner and thicker blank pieces **130** (or **135**) and **120** (or **125**) are clamped by respective clamp plates **312**. In operation, mounting table **331** serves as a positive electrode (anode), and thus, a plasma arc is jetted from arc torch **250** toward the mutually contacting edges **240**.

Groove **333** is used for conveying the sealing gas for sealing the welded portion. Furthermore, due to provision of groove **333**, a welded bead of the mutually contacting edges **240** is prevented from being welded to first and second mounting surfaces **332** and **334** of mounting table **331**.

As is seen from FIG. **19**, for carrying out the welding, arc torch **250** is moved along the mutually contacting edges **240** from one end **242** to the other end **247** while jetting the plasma arc to the contacting edges **240**. With this, the mutually contacting edges **240** are adequately welded to each other throughout the entire length thereof.

Angles "θA" and "θB" are an angle of inclination and an angle of lead, that are kept taken by arc torch **250** during movement of arm torch **250** along the mutually contacting edges **240** for the welding.

In the following, the blanking of metal sheets for producing thicker and thinner blank pieces **120**, **125**, **130** and **135** and the shape of the mutually contacting surfaces **240** of thicker and thinner plates members **120**, **125**, **130** and **135** will be briefly discussed with reference to FIGS. **20**, **21**A and **21**B.

As is understood from FIGS. **20** and **3**, when metal sheet **2**A (or **2**B) is subjected to a blanking or stamping, two pieces are produced. The separated two pieces have each a cut edge **240** that includes a shear face **240**A that is rounded and a rupture face **240**B that is sharply raised.

As is seen from FIG. **2**, left and right thicker blank pieces **120** and **125** are symmetrical in shape, and each blank piece **120** or **125** has upper and lower corner portions **121** or **126** that project inward. This means that for effective and speedy preparation of both left and right blank pieces **120** and **125**, these two types of blank pieces **120** and **125** are stamped out from metal sheet **2**A (or **2**B) by using the same cutting die, and when these blank pieces **120** and **125** are brought onto the clamp device "CLD", one of them, for example, the blank piece to become right thicker blank piece **125**, is turned upside down.

Accordingly, as is shown by FIGS. **21**A and **21**B, two types of arrangement of such thicker blank piece **120** or **125** are inevitably caused relative to thinner blank piece **130** or **135** on the clamp device "CLD".

In case of the arrangement of FIG. **21**A, thicker blank piece **120** (or **125**) is arranged in such a manner that the shear face **240**A thereof is positioned above, while, in case of the arrangement of FIG. **21**B, thicker blank piece **125** (or **120**) is arranged in such a manner that the shear face **240**A is positioned below.

Accordingly, the welding of the mutually contacting edges **240** of thicker and thinner blank pieces **120** and **130** (**120** and **135**, **125** and **130** or **125** and **135**) by the plasma spraying technique should be carried out by taking the above-mentioned two types of arrangement into consideration.

Tests have revealed that, in the arrangement of FIG. **21**A, a satisfied result is obtained when the angles "θA" and "θB" (see FIG. **25**) are 0 to 10 degrees and 10 to 20 degrees respectively, and in the arrangement of FIG. **21**B, a satisfied result is obtained when the angles "θA" and "θB" are 0 to 20 degrees and 10 to 20 degrees respectively.

Tests have further revealed that if mounting table **331** by which first and second mounting surfaces **332** and **334** are defined is increased in size, a sufficient heat radiation is expected by the table **331** under the welding operation. This is important for obtaining a satisfied tailored blank sheet **110** (see FIG. **2**).

If desired, a suitable heat controller may be connected to mounting table **331** for controlling the temperature of the table **331** under the welding operation. Of course, by varying an electric power fed to arc torch **250**, the welded condition of the mutually contacting edges **240** is suitably controlled.

As has been mentioned hereinafore, the tailored blank sheet **110** thus produced is then subjected to a press forming to produce a product that is for example the suspension part **10** of FIG. **1**.

As will be understood from the foregoing description, according to the clamp device "CLD" of the present invention, the following advantageous features are obtained that are not expected in the above-mentioned known clamp devices.

1. In the invention, clamp plates **312** that are pivotal relative to mounting table **331** are arranged beside the table **331** (see FIG. **5**). Thus, with clamp plates **312** being kept raised up, the four different blank pieces **120**, **125**, **130** and **135** can be directly and easily put onto the four pairs of first and second mounting surfaces **332** and **334** of four mounting table **331** from the above.

2. In the invention, positioning of the four blank pieces **120**, **125**, **130** and **135** is carried out by the twelve positioning units **360**A**1**, **360**A**2**, **360**B**1**, **360**B**2**, **360**C, **360**D, **380**, **385**, **390**A, **390**B, **390**C, **390**D.

3. In the invention, the properly positioned four blank pieces **120**, **125**, **130** and **135** can be locked by the lock mechanism that includes left and right locking pawls **341** and **351** for each clamp plate **312**.

That is, in the invention, an isolated preset process for previously setting a mutual positioning between the four blank pieces **120**, **125**, **130** and **135** and an isolated transfer process for transferring the mutually positioned four blank pieces **120**, **125**, **130** and **135** to their proper positions on mounting tables of a clamp device, which have been inevitably needed in the afore-mentioned conventional clamp device, are not needed. That is, in the present invention, such processes are systematically and easily carried out by only the clamp device "CLD".

The entire contents of Japanese Patent Application 2004-106783 filed Mar. 31, 2004 are incorporated herein by reference.

Although the invention has been described above with reference to the embodiment of the invention, the invention is

not limited to such embodiment as described above. Various modifications and variations of such embodiment may be carried out by those skilled in the art, in light of the above description.

What is claimed is:

1. A clamp device for clamping different blank pieces, comprising:

a mounting table on which the different blank pieces are to be placed such that mutually facing edges of the different blank pieces are kept in contact with each other;

a clamp plate configured to clamp one blank piece of the different blank pieces on the mounting table, the clamp plate having a flat surface with side edges;

a pivot mechanism configured to pivotally move the clamp plate from an inoperative position to an operative position where portions of the one blank piece near the mutually facing edges are pressed against the mounting table by the clamp plate, wherein said pivot mechanism comprises a pivoting arm and an actuator to move said pivoting arm; and

a lock unit configured to lock the one blank piece by pressing a side edge of the clamp plate against the one blank piece,

wherein the lock unit comprises:

a pivotal locking pawl configured to lock the side edge of the clamp plate, the locking pawl including a first portion configured to have an upper projection and configured to receive thereon said side edge of the clamp plate such that a given clearance is left between the one blank piece and the clamp plate when the clamp plate is pivotally moved to the operative position by the pivot mechanism and a second portion configured to have a lower projection and configured to be pressed against said side edge of the clamp plate such that the clamp plate is locked against the mounting table when the one blank piece is pressed against the mounting table by the clamp plate; and

a locking pawl actuating mechanism comprising an actuation mechanism and a linking mechanism connected to said locking pawl for forcing pivoting of the pivotal locking pawl between a first angular position wherein the first portion of the locking pawl receives thereon the side edge of the clamp plate leaving the given clearance between the one blank piece and the clamp plate and a second angular position wherein the second portion of the locking pawl is pressed against the side edge of the clamp plate.

2. A clamp device as claimed in claim **1**, wherein the locking pawl is formed with a cut of which opposed inner surfaces are formed on the upper and lower projections.

3. A clamp device as claimed in claim **2**, wherein the locking pawl actuating mechanism comprises a pivot device for permitting a pivot movement of the locking pawl;

wherein the actuation mechanism produces a power when energized; and

wherein the linking mechanism connects the locking pawl to the actuation mechanism such that the pivot movement of the locking pawl is induced upon energization of the actuation mechanism.

4. A clamp device as claimed in claim **3**, wherein the actuation mechanism comprises a cylinder and a piston operatively received in the cylinder,

wherein the linking mechanism comprises an elongate first link and a generally L-shaped second link, the first link having one end pivotally connected to the locking pawl and the other end pivotally connected to one end of the second link,

wherein the second link is pivotal about a pivot pin and has the other end of the second link pivotally connected to the piston, and

wherein when the actuation mechanism is energized, the piston is moved to pivot the locking pawl through the second and first links.

5. A clamp device as claimed in claim **1**, wherein the one blank piece has a thickness larger than that of another blank piece.

6. A clamp device as claimed in claim **5**, wherein the given clearance left between the one blank piece and the clamp plate is so determined as to prevent an edge of the another blank piece from running on an edge of the one blank piece.

7. A clamp device as claimed in claim **6**, wherein the thickness of the given clearance is approximately ½ of that of the another blank piece.

8. A clamp device as claimed in claim **5**, wherein the one blank piece constitutes one side part of a rectangular suspension part of a wheeled motor vehicle and the another blank piece constitutes one upper part of the rectangular suspension part.

9. A clamp device as claimed in claim **1**, wherein the given clearance is so set as to permit a restricted movement of the one blank piece on the mounting table.

10. A clamp device as claimed in claim **9**, further comprising a positioning device by which positioning of the one blank piece is effected.

11. A clamp device as claimed in claim **10**, wherein the positioning device comprises a facing edge positioning device that positions the mutually facing edges of the different blank pieces.

12. A clamp device as claimed in claim **11**, wherein the facing edge positioning device is mounted on the mounting table at a side where the one blank piece is not placed, and wherein the facing edge positioning device comprises a positioning means that moves obliquely.

13. A clamp device as claimed in claim **1**, wherein the mutually facing edges of the different blank pieces are welded.

14. A clamp device as claimed in claim **13**, wherein the welding is made through plasma welding.

15. A clamp device for clamping first and second blank pieces, comprising:

a mounting table on which the first and second blank pieces are placed such that mutually facing edges of the first and second blank pieces are kept in contact with each other;

first and second clamp plates configured to clamp the first and second blank pieces on the mounting table, the clamp plates each having a flat surface with side edges;

first and second pivot mechanisms configured to pivotally move the first and second clamp plates from inoperative positions to operative positions where portions of the first and second blank pieces near the mutually facing edges are pressed against the mounting table by the clamp plates, wherein each pivot mechanism comprises a pivoting arm and an actuator to move the pivoting arm; and

first and second lock units, each being configured to lock its corresponding blank piece by pressing the side edges of the corresponding clamp plate against its corresponding blank piece,

wherein each of the first and second lock units comprises:

two pivotal locking pawls configured to lock opposed side edges of the corresponding clamp plate, each locking pawl including a first portion configured to have an upper projection and configured to receive

thereon the corresponding side edge of the corresponding clamp plate such that a given clearance between the corresponding blank piece and the corresponding clamp plate is left when the corresponding clamp plate is pivotally moved to the operative position by the corresponding pivot mechanism, and a second portion configured to have a lower projection and configured to be pressed against its corresponding side edge of the corresponding clamp plate such that the corresponding clamp plate is locked against the mounting table when the corresponding blank piece is pressed against the mounting table by the corresponding clamp plate; and

two locking pawl actuating mechanisms comprising actuation mechanisms and linking mechanisms connected to the two locking pawls and configured to pivot the two pivotal locking pawls between a first angular position wherein the first portion of each locking pawl receives thereon the corresponding side edge of the corresponding clamp plate such that the given clearance between its corresponding blank piece and the corresponding clamp plate is left and a second angular position wherein the second portion of each locking pawl is pressed against the corresponding side edge of the corresponding clamp plate.

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